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SE 005-001-1 REVISION A

OFFICE OF
MANNED SPACE
FLIGHT

APOLLO PROGRAM

APOLLO PROGRAM SPECIFICATION [redacted]

MARCH 1, 1966

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IONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

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Specification No. SE 005-001-1
Revision A
Dated March 1, 1966

CLASSIFICATION CHANGE

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APOLLO PROGRAM SPECIFICATION [redacted]

Approved ~~by:~~ Samuel C. Phillips

SAMUEL C. PHILLIPS
Major General, USAF
Apollo Program Director

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

IN REPLY REFER TO:

March 1, 1966

TO: Distribution

FROM: Director, Apollo Program

SUBJECT: Apollo Program Specification

The document transmitted herewith is Revision A dated March 1, 1966, of the Apollo Program Specification. This is the first level technical specification for Apollo systems and the requirements set forth shall be fully reflected in subsidiary Apollo specifications and implemented by all cognizant elements of the Apollo Program.

All proposed changes shall be submitted to the Apollo Program Office Configuration Control Board for approval using the procedure defined in Exhibit VIII of NPC 500-1. Approved changes will be distributed as new dated pages which will replace existing pages. A Specification Change Log will be issued with each new page or set of pages to indicate the page or pages affected, the issue date and the SCN number.

This revision supersedes the May 1965 version and includes those program requirement changes that have been approved by the Apollo Program Office Configuration Control Board since that time.

Samuel C. Phillips

Samuel C. Phillips
Major General, USAF

Enclosure

CONFIGURATION CHART

SPECIFICATION ISSUE	INCORPORATED SCN'S	
BASIC May, 1965		
REVISION A March 1, 1966	1-1 and 1-2	18-1 thru 18-31
	2-1 and 2-2	19-1
	3-1	20-1
	4-1 thru 4-6	21-1
	5-1	22-1 thru 22-3
	6-1	23-1 thru 23-4, 23A-5 and 23A-6
	7-1	24-3 thru 24-20
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	17-1 thru 17-5	

June 17, 1966

C66-3617

SPECIFICATION CHANGE LOG
Spec. No. SE 005-001-1, Rev. A

The attached new pages contain changes to the Apollo Program Specification that have been approved by the Apollo Program Office Configuration Control Board. The portion of the text affected by the current revision is indicated by a vertical line in the outer margins of the page. Insert the latest revised pages and destroy superseded pages. File this Specification Change Log immediately behind the Configuration Chart in the front of the Specification. Destroy superseded Specification Change Log.

List of Revised Pages Issued

Page	Date	SCN	Page	Date	SCN
Table 10.1-2*	6/17/66	38-1*			
202-3	4/26/66	36-1			
202-15	4/ 1/66	29-1			
203-3	4/26/66	36-1			
204-3	4/26/66	36-1			
501-3	4/26/66	36-2			
503-2	4/ 1/66	35-1			
504-1	4/ 1/66	35-2			
504-3	4/ 1/66	35-3			

*The asterisk indicates material revised or added by the current revision.

[redacted]

TABLE 10.1-2

SATURN V CONTROL WEIGHTS

CONTROL POINT	ITEM	CONTROL WEIGHT (lbs.) 501	502	503	504 (NOTE 3)	505 (NOTE 3)	506 to 525
S-IC	DRY WEIGHT	312,500	312,500	312,500	304,500	304,500	300,000
	PROPELLANT TANK CAPACITY	4,400,000	4,400,000	4,400,000	4,400,000	4,400,000	4,400,000
	SEPARATION WEIGHT	381,518	381,518	381,518	373,518	373,518	369,018
S-IC/S-II INTERSTAGE	TOTAL WEIGHT	14,200	14,200	14,200	14,100	14,100	14,100
S-II	DRY WEIGHT	89,000	89,000	89,000	86,000	86,000	83,000
	PROPELLANT TANK CAPACITY	930,000	930,000	930,000	930,000	930,000	930,000
	SEPARATION WEIGHT	99,259	99,259	99,259	96,239	96,239	93,239
S-II/S-IVB INTERSTAGE	TOTAL WEIGHT	7,700	7,700	7,700	7,700	7,700	7,700
S-IVB	DRY WEIGHT	28,200	28,200	28,200	28,100	28,100	27,400
	PROPELLANT TANK CAPACITY	230,000	230,000	230,000	230,000	230,000	230,000
	INJECTION WEIGHT (NOTE 1)	30,491	30,491	30,491	30,391	30,391	29,691
INSTRUMENT UNIT	TOTAL WEIGHT	4,650	4,650	4,650	4,650	4,650	4,150
LAUNCH VEHICLE	PAYLOAD CAPABILITY (NOTE 2)	85,000	85,000	85,000	93,000	93,000	95,000

6/17/66
SCN 38-1

NOTE 1 Does not include Flight Performance Reserves.

NOTE 2 All payload capabilities are based on the Launch Vehicle Payload Requirements given in 10.1.4.

NOTE 3 The payload capability of vehicles 504 and 505 is 2000 lbs. less than that of operational vehicles because of removable R&D instrumentation.

This document contains information affecting the National Defense of the United States within the meaning of the Espionage Laws, Title 18 U.S.C., Sections 793 and 794, the transmission or revelation of which in any manner to an unauthorized person is prohibited by law.

[redacted]

GROUP-4
Downgraded at 3 year intervals; declassified after 12 years

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LIST OF TABLES

1.0 <u>Scope</u> This specification delineates performance, design and test requirements for the Apollo Program as defined by the Apollo Program Development Plan (PDP), NPC C500.

The body of the specification applies to the Apollo Program equipment to be provided for the lunar landing mission and the operational version of the Saturn IB launch vehicle with their associated launch facilities. A description of this equipment is contained in Section 9 of the Apollo Program Development Plan, NPC C500.

The appendices to the body of the specification delineate the performance, design and test requirements as they apply to Apollo Program equipment to be used on individual missions specified in M-D MA 500-11, Apollo Flight Mission Assignments. These requirements are delineated by identifying the changes to requirements stated in the body of the specification.

1.1 <u>Applicability</u> All requirements specified herein shall be reflected in subsidiary specifications of the Apollo Program.

1.2 <u>Change Approval</u> Changes shall be submitted in accordance with Exhibit VIII of the Apollo Configuration Management Manual, NPC 500-1.

2.0 Applicable Documents The following documents form a part of this specification and are applicable without change.

NHB 5300.1 October, 1965	Apollo Reliability and Quality Assurance Program Plan
M-DE 8020.008B April, 1965	Natural Environment and Physical Standards for the Apollo Program
MIM 7000.029 June 2, 1964	MSF Instruction to MSC: Biomedical Data Requirements
NPC C500 January 15, 1965	Apollo Program Development Plan
NPC 500-10 May 20, 1964	Apollo Test Requirements
M-D MA 500-11 (SE 010-000-1) September 10, 1965	Apollo Flight Mission Assignments
	Apollo Inter-Center Control Document Log (published monthly)
SE 008-001-1 June, 1965	Project Apollo Coordinate System Standards

The following documents are applicable to the extent specified herein.

Webb-McNamara Agreement January 17, 1963	Agreement between the Department of Defense and the National Aeronautics and Space Administration regarding management of the Atlantic Missile Range of DoD and the Merritt Island Launch Area of NASA

NPC 500-1 May 18, 1964	Apollo Configuration Management Manual
M-DE 8000.006 (CM 018-001-1) June 1, 1963	OMSF Directive, Mass Properties Standards

<u>Specifications</u>

MIL-D-70327 March 27, 1962	Drawings, Engineering and Associated Lists
MIL-E-6051C	Electrical-Electronic System Compatibility and Interference Control Requirements for Aeronautical Weapon Systems, Associated Subsystems, and Aircraft
MIL-I-26600 May 9, 1960	Interference Control Requirements, Aeronautical Equipment
MIL-I-6181D June 1, 1962	Interference Control Requirements, Aircraft Equipment

3.0 Requirements

3.1 Performance

3.1.1 Characteristics

3.1.1.1 General The Apollo Program is a focal point of the national space program, the objective of which is to demonstrate and maintain preeminence in space and space technology. The objective of the Apollo Program is to carry out manned expeditions to the Moon for the purpose of conducting scientific exploration on the lunar surface. It is intended that the information and technology developed by the Apollo Program shall provide the foundation for extensive planetary exploration, for further lunar exploration and for extended Earth orbital activities.

Apollo lunar landing missions shall not be attempted until in-flight and lunar surface environmental information essential for design verification has been obtained.

The primary considerations which must be weighed in the design and implementation of the Apollo system are listed below in order of decreasing priority.

(a) Crew Safety and Mission Success Crew safety and mission success shall be the primary considerations in the design of the system. Crew safety is defined as the safe return of all crew members whether or not the mission is completed. Mission success is defined as the safe return of all crew members after a lunar landing.

(b) Schedule Accomplishment of a manned lunar landing mission as early as possible, but before the end of 1969, is a national objective. Design approaches and decisions shall be made in recognition of this objective but not at the expense of confidence in crew safety or mission success.

(c) Growth Potential Accommodations have been made in the design of Apollo equipment to provide growth potential where such accommodations have not compromised crew safety, mission success or the schedule of the primary mission. Additional requirements for growth potential may be incorporated by changes to this specification or by incorporation in the appendices.

3.1.1.2 Mission Performance

3.1.1.2.1 Mission Mode The Apollo mission shall be achieved using the Lunar Orbit Rendezvous (LOR) mode. In this mode, the Saturn V launch vehicle, consisting of an S-IC first stage, an S-II second stage, an S-IVB third stage, and an Instrument Unit (IU) shall launch the spacecraft, propel it through an Earth parking orbit phase and inject it into a lunar transfer trajectory. The spacecraft, consisting of a Command Module (CM), a Service Module (SM) and a Lunar Excursion Module (LEM) shall utilize the SM for propulsion after injection and until attainment of a lunar parking orbit. Two of the three crew members in the CM shall transfer to the LEM, which shall separate from the Command/Service Module (CSM) and descend to the lunar surface. After lunar exploration, the two crew members shall ascend in the LEM on a trajectory that shall permit rendezvous and docking with the orbiting CSM. After the LEM crew has transferred to the CSM, the LEM shall be jettisoned in lunar orbit. The CSM shall be returned to the Earth by SM propulsion. The SM shall be jettisoned prior to entry of the CM into the Earth's atmosphere. The CM shall be slowed to a safe landing by aerodynamic braking and, during the final phases of the landing sequence, by parachute.

3.1.1.2.2 Mission Command Primary command and decision making shall be exercised by Earth-based personnel. The Manned Space Flight Network (MSFN) shall be used for communication with the space vehicle, including television, voice and data, and for tracking of the space vehicle (the existing configuration of launch vehicle stages and spacecraft modules at a given point in the mission) during the Apollo mission. Independent of Earth-based support, the spacecraft crew shall be provided with the capability of completing or aborting the mission.

3.1.1.2.3 Payload The Apollo space vehicle shall be capable of landing two astronauts and a minimum of 250 pounds of scientific payload on the Moon, and returning the astronauts and a minimum of 80 pounds of scientific payload safely to Earth. This capability shall be provided on any day of the year and for any preselected lunar landing site within the area generally described by $\pm 5^{\circ}$ latitude and $\pm 45^{\circ}$ longitude. Further, this capability shall be provided when using a free return translunar trajectory whenever such is consistent with the ΔV budget of Table 3.5-1.

3.1.1.2.4 Earth Launch The capability shall be provided for launch: (a) on any one of three successive days each of which contains at least one launch window of at least 2.5 hours duration, (b) during day and night and (c) on any true azimuth between 072° and 108°.

3.1.1.2.5 Earth Parking Orbit The capability shall be provided for performing the mission with a near-circular Earth orbit with altitude between 85 and 105 nautical miles (nm).

3.1.1.2.6 Injection Opportunities Injection into a lunar transfer trajectory shall occur no later than 4.5 hours after Earth orbit insertion. The capability shall be provided for injection on either of two successive Earth orbits.

3.1.1.2.7 Lunar Landing Accuracy The capability shall be provided for landing the astronauts at a preselected landing point on the lunar surface independent of lunar-based landing aids with a CEP of 0.5 nm excluding hover capability. With landing aids the CEP shall be 100 feet.

3.1.1.2.8 Lunar Exploration The capability shall be provided for a stay time of 35 hours on the lunar surface (see 3.5.1.16). This capability shall be provided for either lunar day or lunar night conditions as specified in the appropriate mission appendix to this specification. The capability shall be provided to permit the astronauts to explore the lunar surface for distances of approximately 0.5 nm from the LEM, lunar terrain permitting.

3.1.1.2.9 Earth Landing The normal Earth landing mode shall be on water. The capability for water and land landing shall be as specified in 3.5.1.24. The capability shall be provided for return of the crew and CM to a landing within the latitude limits of 40°N and 40°S at any prespecified area determined by recovery support requirements.

3.1.1.2.10 Recovery Recovery forces shall be provided which shall have the capability for recovering the CM and crew after a landing at locations specified in the appropriate mission operations plan.

3.1.2 Program Definition

3.1.2.1 Apollo Program Specification Tree The upper levels of the program specification tree are shown in Figure 3.1-1.

3.1.2.2 Inter-Center Interface Control Documents Inter-Center Interface Control Documents are coordinated among Centers by a procedure established in 1.4.7 of the Apollo Program Development Plan, NPC C500. These documents are identified in the current Apollo Inter-Center Interface Control Document Log. These documents shall reflect the requirements of this specification and shall control the more detailed design requirements in their respective areas after approval by the affected Centers.

3.1.3 Operability

3.1.3.1 Logistics This section contains logistic requirements as they affect the design of equipment. Additional requirements related to the Apollo Program Logistics Management System are contained in Section 6 of the Apollo Program Development Plan NPC C500. Logistics requirements must support the reliability requirements stated in 3.1.3.3.

3.1.3.1.1 Maintainability Spece vehicles shall be designed so that maintenance is not required in flight or on the lunar surface. The design shall permit removal and replacement of "black boxes" during the preflight phase without access to their interiors and with minimal disturbance to the integrity of other assemblies. After replacement, the equipment performance shall be at least equal to that of the initial installation.

Items having the same functional and performance requirements shall be designed to be interchangeable wherever practicable.

Test points shall be provided in space vehicle subsystems to permit fault isolation to the "black box" level. Ground Support Equipment shall provide the capability for fault isolation in the space vehicle to the "black box" level.

Ground maintenance capability, when combined with the equipment reliability, shall provide the capability of meeting a launch commitment with the reliability specified in 3.1.3.3.

3.1.3.1.2 Transportability The S-IB, S-IC and S-II stages shall be capable of being transported by water and land. All other flight equipment shall be designed to be transportable by water, land or air. Instrumentation shall be provided to record those stresses encountered during transportation which could degrade equipment performance.

Stages and modules shall be transportable in an assembled form whenever practicable. Provisions shall be made for removal of propellants, explosives and other hazardous materials prior to shipment.

3.1.3.1.3 Shelf Life The equipment design, packaging and storage environment shall permit a shelf life of at least five years wherever practicable.

3.1.3.2 Safety All Apollo flight and ground equipment and facilities shall be designed in accordance with the requirements set forth in Section 11 of the Apollo Program Development Plan, NPC C500. Crew safety goals and design requirements are given in 3.1.3.3. Additional safety considerations related to the performance of particular stages, modules and subsystems are contained in the appropriate sections of this specification.

3.1.3.3 Reliability

3.1.3.3.1 Equipment Reliability The numerical values of reliability to be used as requirements for engineering design and as a standard for evaluating test results are given in Table 3.1-2. They are stated as the probability that the equipment will successfully perform its function during the mission. They shall not preclude, however, the taking of all practicable steps in the design of flight and ground equipment, the planning of flight and ground tests, the formulation of mission profiles and mission rules and the training of the crew and operating personnel to insure mission success and crew safety. (Mission success and crew safety are defined in 3.1.1.1.)

3.1.3.3.2 Environmental Hazards The equipment for the lunar landing mission shall be designed to cope with energetic particulate radiation, micrometeoroids and unfavorable characteristics of the lunar surface.

The reliability value of 0.99 shall be met or exceeded for each of these hazards based on the models given in M-DE

TABLE 3.1-2

EQUIPMENT RELIABILITY

Phase	Equipment		Success Probability[4]
Preflight[1]	Launch Vehicle[3]		0.97
	Spacecraft[3]		0.98
	Launch Complex and Ground Support		0.95
Flight[2]	Launch Vehicle	S-IC	0.95
		S-II	0.95
		S-IVB	0.95
		IU	0.99
	Spacecraft	CSM/LES	0.96
		LEM/Adapter	0.98
	Ground Support		0.99

1. The preflight phase begins with the removal of the assembled space vehicle from the Vertical Assembly Building (VAB) and ends with liftoff within the scheduled period of three consecutive days as specified in 3.1.1.2.4.
2. The flight phase begins with space vehicle liftoff from the launch pad and terminates with recovery of the crew and the CM.
3. Including vehicle-peculiar Ground Support Equipment.
4. Does not include effect of environment hazards as specified in 3.1.3.3.2.

8020.008B, Natural Environment and Physical Standards for the Apollo Program.

3.1.3.3.3 <u>Crew Safety</u> The numerical values for the probability of crew safety that shall be met or exceeded in the engineering design are:

(a) 0.99 for the spacecraft and those elements of the launch complex and ground system which support its operation,

(b) 0.99 for the launch vehicle and those elements of the launch complex and ground equipment which support its operation.

It is expected that the crew safety probabilities will be used mainly to estimate numerically a tradeoff between competing crew safety and mission success design requirements.

3.1.3.3.4 <u>System Design Policy</u> A primary policy governing the design of the system is that wherever possible no single failure shall cause the loss of any crew member, prevent the successful continuation of the mission, or in the event of a second failure in the same area, prevent a successful abort of the mission.

In those areas in which performance and reliability requirements can be met by the use of established technology, the design shall not be made dependent upon the development of new components or techniques based on new art and technology.

3.1.3.3.5 <u>Reliability Assurance</u> Assurance as to the reliability of each article required for the success or safety of a mission will be mainly obtained by proper design qualification and inspection. A primary policy governing design qualification for any given Apollo mission is that, to the extent practicable, prior flight and/or ground tests shall demonstrate that the system is capable of meeting mission requirements. The design procedure will include documented analysis of all failures observed in the test programs and the elimination of the cause for all such failures. The test program will provide data so that an engineering appraisal can be made to determine that the design is capable of meeting the reliability apportionment. See 4.0 - Quality Assurance.

3.2 Program Standards

3.2.1 Natural Environment and Physical Standards The natural environment data that shall be used in the Apollo Program are contained in Natural Environment and Physical Standards for the Apollo Program, M-DE 8020.008B. Specific applications are called out in other sections of this specification. The apportionment of design reliability necessary to overcome environmental conditions is included in the requirements of 3.1.3.3.

Unless otherwise noted, a sea level gravitational acceleration (g) of 980.665 cm/sec^2 shall be used throughout this specification as a reference of measurement.

3.2.2 Electromagnetic Interference Control All systems and subsystems of the Apollo Program shall be designed in accordance with the requirements of MIL-E-6051C. Equipment in the systems and subsystems shall be designed in accordance with the requirements of MIL-I-26600 or MIL-I-6181D, as applicable. Modifications of these specifications for use in the Apollo Program shall be approved by the cognizant NASA Centers.

3.2.3 Drawings All drawings shall be prepared in accordance with MIL-D-70327 and NASA Cover Sheet Specification for Drawings, Engineering and Associated Lists, NASA A9204S001A dated December 15, 1964.

3.2.4 Configuration Management Configuration management procedures shall be as described in Section 5 of the Apollo Program Development Plan, NPC C500.

3.2.5 Coordinate System Standards The Project Apollo Coordinate System Standards, SE 008-001-1, contains the approved coordinate system standards for the Apollo Program. These standards shall be used throughout the Apollo Program.

3.3 Saturn IB Launch Vehicle

3.3.1 General The Saturn IB launch vehicle shall be composed of two stages, S-IB and S-IVB (Saturn IB version), and an Instrument Unit (IU), (Saturn IB version). The launch vehicle control weights shall be as specified in Table 10.1-1, Appendix 10.1. The S-IVB and IU (Saturn IB versions) shall be capable of maintaining attitude control of the spacecraft for 4.5 hours in Earth orbit. Components of the S-IVB and IU (Saturn IB versions) shall be identical with those of the S-IVB and the IU (Saturn V versions) where practicable. In addition, the S-IVB stage and the IU (Saturn IB versions) shall be capable of meeting the requirements of this specification under the natural environment of terrestrial space as given in Section 3 of M-DE 8020.008B.

3.3.1.1 Payload The launch vehicle shall have the payload capability specified in Table 10.1-1 of Appendix 10.1.

3.3.1.2 Standby Time The launch vehicle shall have the capability to stand by in a loaded condition with propellant topping for 12 hours and still perform the mission.

3.3.1.3 Prelaunch Checkout See 3.4.1.3.

3.3.1.4 In-Flight Performance Evaluation See 3.4.1.4.

3.3.1.5 Emergency Detection Subsystem See 3.4.1.5.

3.3.1.6 Instrumentation See 3.4.1.6.

3.3.1.7 Command Destruct See 3.4.1.7.

3.3.1.8 Electrical Power See 3.4.1.8.

3.3.2 Structure The launch vehicle structure shall be self-supporting with the propellant containers pressurized or unpressurized.

3.3.2.1 Prelaunch Environment See 3.4.2.1.

3.3.2.2 Launch and Flight Environment See 3.4.2.2.

3.3.3 Propulsion

3.3.3.1 S-IB Stage

3.3.3.1.1 Main Propulsion Subsystem The main propulsion subsystem shall consist of eight H-1 liquid-propellant rocket engines. Four of these engines shall be gimbal-mounted for flight control purposes.

3.3.3.1.1.1 Propellants The H-1 engines shall utilize liquid oxygen and RP-1 as propellants.

3.3.3.1.1.2 Thrust Each H-1 engine shall provide a sea level thrust of 205,000 ± 2000 pounds.

3.3.3.1.1.3 Specific Impulse Each H-1 engine shall provide a nominal sea level specific impulse of 263 seconds. The minimum sea level specific impulse shall be 260 seconds.

3.3.3.1.2 Retrorocket Subsytem The retrorocket subsystem, in conjunction with the S-IVB stage ullage rockets, shall provide the thrust for separation of the S-IB stage from the S-IVB stage. Failure of one retrorocket shall not prevent separation.

3.3.3.2 S-IVB Stage

3.3.3.2.1 Main Propulsion Subsystem The main propulsion subsystem shall consist of one J-2 engine gimbal-mounted for pitch and yaw control.

3.3.3.2.1.1 Propellants See 3.4.3.2.1.1.

3.3.3.2.1.2 Thrust Each J-2 engine shall provide a vacuum thrust of 200,000 ± 6000 pounds.

3.3.3.2.1.3 Specific Impulse See 3.4.3.2.1.3.

3.3.3.2.2 Auxiliary Propulsion Subsystem The auxiliary propulsion subsystem shall provide thrust for roll control during powered flight and attitude control about three axes during unpowered flight. The auxiliary propulsion subsystem shall utilize nitrogen tetroxide and monomethylhydrazine as propellants.

3.3.3.2.3 Ullage Rocket Subsystem See 3.4.3.2.3.

3.3.4 Launch Vehicle Guidance, Navigation and Control

3.3.4.1 General The launch vehicle guidance, navigation and control system shall provide the guidance, navigation and control functions which are required for the space vehicle from liftoff through separation of the spacecraft from the launch vehicle. The principal elements shall be an inertial measurement unit (IMU), a digital computer and control electronics. These elements shall be located in the IU.

3.3.4.1.1 The launch vehicle guidance, navigation and control system shall:

(a) Be capable of automatic operation independent of external commands during thrusting phases.

(b) Be capable of accepting from the ground, during coasting phases of the mission, commands to initiate operations and data for updating the information stored in the digital computer.

(c) Be capable of guiding the space vehicle into Earth orbit without plane change at any time within the launch window.

(d) Not require realignment of its inertial attitude reference after launch.

(e) Include a means for checkout of the launch vehicle guidance, navigation and control system, both on the launch pad and in Earth parking orbit.

3.3.4.1.2 The capability shall be provided in the launch vehicle to utilize CM guidance and control commands as an alternative means of:

(a) Attitude control of space vehicle during the coasting phase of the mission which occurs after S-IVB ignition.

(b) Space vehicle guidance and control for Earth orbit insertion after S-IVB ignition.

3.3.5 Saturn IB Launch Vehicle Communications and Tracking

3.3.5.1 General The general requirements shall be the same as for the Saturn V launch vehicle Communication and Tracking System stated in 3.4.5.1.

3.3.5.2 Functional Capability

3.3.5.2.1 Telemetry The telemetry subsystem shall be able to:

(a) Transmit data required for operational control by an independent transmitter in each stage and the IU.

(b) Transmit the data required for postflight analysis.

(c) Operate continuously in the S-IVB and IU for at least 4.5 hours after launch.

3.3.5.2.2 Tracking Aid The tracking aid subsystem shall enable the MSFN and Eastern Test Range (ETR) stations to track the launch vehicle continuously by at least two independent means during the launch phase irrespective of vehicle attitude. The tracking aid subsystem in the IU shall be able to:

(a) Operate continuously for at least 4.5 hours after launch.

(b) Permit angle and range tracking when in line-of-sight of suitably equipped MSFN stations.

3.3.5.2.3 Up-Data The up-data subsystem in the IU shall be able to receive data from the MSFN for at least 4.5 hours after launch.

The up-data subsystem shall be able to supply verification signals to the MSFN via the S-IVB and IU operational telemetry transmitters.

3.3.5.2.4 Command Destruct The command destruct requirements shall be the same as for the Saturn V launch vehicle stated in 3.4.5.2.4.

3.3.5.3 Coverage Capability The Saturn IB Communication and Tracking System shall be able to operate with the MSFN to achieve the coverage specified in Table 3.7-4.

3.3.5.4 Performance The Saturn IB Communication and Tracking System shall meet the requirements specified in Table 3.3-1.

3.4 Saturn V Launch Vehicle

3.4.1 General The Saturn V launch vehicle shall be composed of three stages, S-IC, S-II and S-IVB, and an IU. The launch vehicle control weights shall be as specified in Table 10.1-2, Appendix 10.1. The S-IVB stage and the IU shall be capable of meeting the requirements of this specification when subjected to the natural environment of terrestrial space as given in Section 3 of M-DE 8020.008B.

3.4.1.1 Payload The launch vehicle shall have the payload capability specified in Table 10.1-2 of Appendix 10.1.

3.4.1.2 Standby Time The launch vehicle shall have the capability to stand by in a loaded condition with propellant topping for the duration of the launch window and still perform the mission. The launch vehicle shall have the capability for meeting a launch window on each of three successive days.

3.4.1.3 Prelaunch Checkout The launch vehicle shall be designed to facilitate remote checkout during the prelaunch phase by automated equipment designed in accordance with the requirements of 3.6.2.

3.4.1.4 In-Flight Performance Evaluation The S-IVB/IU shall be designed to facilitate in-flight system performance and status evaluation by the MCC.

3.4.1.5 Emergency Detection Subsystem (EDS) The launch vehicle shall contain an EDS which shall be capable of sensing incipient launch vehicle failures which might result in crew loss. EDS information shall be provided for display to the crew and to ground personnel. The EDS shall have the capability to initiate automatically the crew escape sequence if the failure is such that the crew would not have time to escape safely by manual initiation.

3.4.1.6 Instrumentation An instrumentation subsystem shall be provided in the launch vehicle to permit the crew and ground personnel to monitor and evaluate launch vehicle performance.

3.4.1.7 Command Destruct The launch vehicle shall contain two separate command destruct subsystems on each propulsive stage for emergency thrust termination and propellant dispersal on ground command. The propellant dispersal subsystem shall be designed so that it is armed by receipt of an emergency thrust termination signal. A second discrete ground command shall be required to actively disperse the propellants (see 3.4.5.2.4).

3.4.1.8 Electrical Power Electrical power shall be supplied by batteries during flight and by ground support equipment during checkout, countdown and standby periods. Separate batteries shall be provided in each stage and in the IU.

3.4.1.9 Attitude Control The S-IVB stage in conjunction with the IU shall be capable of maintaining the space vehicle at commanded attitudes for 4.5 hours during Earth orbit, and for 2 hours after injection into translunar trajectory to allow transposition and dock.

3.4.2 Structure The space vehicle shall be capable of being transported in a vertical position from the VAB to the launch site (see 3.6.3). In addition, the space vehicle shall have a freestanding capability, with the propellant containers pressurized or unpressurized, on the launch pad during 99.9 percentile peak surface wind conditions given in 2.3.2.1 of M-DE 8020.008B.

3.4.2.1 Prelaunch Environment During the prelaunch period, the space vehicle shall be capable of withstanding the natural ground environment given in 2.2 of M-DE 8020.008B.

3.4.2.2 Launch and Flight Environment The space vehicle shall be capable of being launched in the 95 percentile peak surface wind conditions given in 2.3.2.3 of M-DE 8020.008B and associated wind shears given in 2.3.2.4 of M-DE 8020.008B. The space vehicle shall be capable of flight in the 95 percentile quasi-steady state in-flight winds given in 2.3.2.5 of M-DE 8020.008B. In addition, the vehicle shall be capable of flight with 85 percent of the 99 percentile wind shears given in 2.3.2.6 of M-DE 8020.008B, and with 85 percent of the quasi-square wave gust given in 2.3.2.8 of M-DE 8020.008B both superimposed on the 95 percentile quasi-steady state in-flight winds given in 2.3.2.5 of M-DE 8020.008B.

3.4.3 Propulsion

3.4.3.1 S-IC Stages

3.4.3.1.1 Main Propulsion Subsystem The main propulsion subsystem shall consist of five F-1 liquid-propellant rocket engines. Four of these engines shall be gimbal-mounted for flight control purposes.

3.4.3.1.1.1 Propellants The F-1 engines shall utilize liquid oxygen and RP-1 as propellants.

3.4.3.1.1.2 Thrust Each F-1 engine shall provide a sea level thrust of $1{,}522{,}000\,^{+23{,}000}_{-22{,}000}$ pounds.

3.4.3.1.1.3 Specific Impulse Each F-1 engine shall provide a nominal sea level specific impulse of 264.5 seconds. The minimum sea level specific impulse shall be 263 seconds.

3.4.3.1.2 Retrorocket Subsystem The retrorocket subsystem, in conjunction with the S-II stage ullage rockets, shall provide the thrust for separating the S-IC stage from the S-IC/S-II interstage. Failure of one retrorocket shall not prevent separation.

3.4.3.2 S-II Stage

3.4.3.2.1 Main Propulsion Subsystem The main propulsion subsystem shall consist of five J-2 liquid propellant rocket engines. Four of these engines shall be gimbal-mounted for flight control purposes.

3.4.3.2.1.1 Propellants The J-2 engine shall utilize liquid oxygen and liquid hydrogen as propellants.

3.4.3.2.1.2 Thrust Each J-2 engine shall provide a vacuum thrust of 205,000 ± 6,150 pounds.

3.4.3.2.1.3 Specific Impulse Each J-2 engine shall provide a nominal vacuum specific impulse of 426 seconds. The minimum vacuum specific impulse shall be 422 seconds.

3.4.3.2.2 Retrorocket Subsystem The retrorocket subsystem, in conjunction with the S-IVB auxiliary propulsion subsystem, shall provide the thrust for separating the S-II stage from the S-IVB stage. Failure of one retrorocket shall not prevent separation.

3.4.3.2.3 Ullage Rocket Subsystem The ullage rocket subsystem shall provide the thrust for propellant settling sufficient for J-2 engine ignition. Failure of one ullage rocket shall not prevent effective propellant settling.

3.4.3.3 S-IVB Stage

3.4.3.3.1 Main Propulsion Subsystem The main propulsion subsystem shall consist of one J-2 engine as specified in 3.4.3.2.1, gimbal-mounted for pitch and yaw control. The engine shall be capable of at least one orbital restart. The subsystem shall be designed for continuous venting of propellant boiloff during coast.

3.4.3.3.2 Auxiliary Propulsion Subsystem The auxiliary propulsion subsystem shall provide thrust for: (a) roll control during powered flight, (b) attitude control about three axes during coast and (c) propellant settling for J-2 engine restart. To the extent that unused propellants permit, the auxiliary propulsion subsystem shall also be used to alter the flight path of the S-IVB/IU in order to avoid impact with the spacecraft after separation. The auxiliary propulsion subsystem shall utilize nitrogen tetroxide and monomethylhydrazine as propellants.

3.4.3.3.3 Ullage Rocket Subsystem The ullage rocket subsystem shall provide the thrust for propellant settling sufficient for initial J-2 engine ignition. Failure of one ullage rocket shall not prevent effective propellant settling.

3.4.4 Guidance, Navigation and Control

3.4.4.1 General The launch vehicle guidance, navigation and control system shall provide the guidance, navigation and control functions which are required for the space vehicle from liftoff through transposition and docking. The principal elements shall be an inertial measurement unit (IMU), a digital computer and control electronics. These elements shall be located in the IU.

3.4.4.1.1 The launch vehicle guidance, navigation and control system shall:

(a) Be capable of automatic operation independent of external commands during thrusting phases.

(b) Be capable of accepting from the ground, during coasting phases of the mission, commands to initiate operations and data for updating the information stored in the digital computer.

(c) Be capable of guiding the space vehicle into Earth orbit without plane change at any time within the launch window.

(d) Not require realignment of its inertial attitude reference after launch.

(e) Include a means for checkout of the launch vehicle guidance, navigation and control system both on the launch pad and in Earth orbit.

3.4.4.1.2 The capability shall be provided in the launch vehicle to utilize CM guidance and control commands as alternative means of:

(a) Attitude control of the space vehicle during coasting phases of the mission which occur after S-IVB ignition.

(b) Space vehicle guidance and control for Earth orbit insertion after S-II ignition.

(c) Space vehicle guidance and control for translunar injection.

3.4.4.2 Accuracy The accuracy requirements for the launch vehicle navigation, guidance and control system are specified by the following allowable bounds at the cutoff of translunar injection

$$\delta\text{position} = 10{,}000 \text{ feet}$$

$$\delta\dot{x} = 15 \text{ feet/sec}$$

$$\sqrt{(\delta\dot{y})^2 + (\delta\dot{z})^2} = 100 \text{ ft/sec}$$

The error components are given in an Earth-centered, right-handed rectangular coordinate system with the y axis passing through the nominal cutoff point and the x axis lying in the nominal orbit plane. The error components are measured from the nominal cutoff conditions.

3.4.5 Saturn V Launch Vehicle Communications and Tracking

3.4.5.1 General The Communication and Tracking System of the Saturn V launch vehicle shall have the following capabilities:

(a) Telemetry transmission.

(b) Tracking aid.

(c) Up-data reception.

(d) Command-destruct data reception.

3.4.5.2 Functional Capability

3.4.5.2.1 Telemetry The telemetry subsystem shall be able to:

(a) Transmit data required for operational control by an independent transmitter in each stage and the IU.

(b) Transmit the data required for postflight analysis.

(c) Operate continuously in the S-IVB and IU for at least 6.5 hours after launch.

3.4.5.2.2 Tracking Aid The tracking aid subsystem shall enable the MSFN and ETR stations to track the launch vehicle continuously by at least two independent means during the launch phase irrespective of vehicle attitude. The tracking aid subsystem in the IU shall be able to:

(a) Operate continuously for at least 6.5 hours after launch.

(b) Permit angle and range tracking when in line-of-sight of suitably equipped MSFN stations.

3.4.5.2.3 Up-Data The up-data subsystem in the IU shall be able to receive data from the MSFN for at least 6.5 hours after launch. The up-data subsystem shall be able to supply verification signals to the S-IVB and IU operational telemetry transmitters for transmission to the MSFN.

3.4.5.2.4 Command Destruct The command destruct subsystem shall:

(a) Include two sets of identical and independent command receivers and decoders on each propulsive stage.

(b) Be compatible with and be operable by the range safety command transmitters installed at the stations of ETR.

(c) Permit continuous data reception irrespective of vehicle attitude from liftoff until the predicted impact points of the stages are outside of the areas specified by range safety.

3.4.5.3 Coverage Capability The Saturn V Communication and Tracking System shall be able to operate with the MSFN to achieve the coverage specified in Table 3.7-3.

3.4.5.4 Performance The Saturn V Communication and Tracking System shall meet the requirements specified in Table 3.4-1. The Command and Communication System (CCS) in the IU, which operates at the same frequencies as the Unified S-Band (USB) subsystem in the LEM, shall be capable of being deactivated after separation of the spacecraft from the launch vehicle.

3.5 Spacecraft

3.5.1 General The spacecraft shall be composed of a Command Module (CM), Service Module (SM), Launch Escape System (LES), Adapter and Lunar Excursion Module (LEM). The LEM shall be composed of an ascent stage and a descent stage. The spacecraft shall be designed to be mated to either a Saturn IB or a Saturn V launch vehicle.

Spacecraft control weights shall be as specified in Table 10.1-4, Appendix 10.1. Spacecraft propulsion performance characteristics, including the ΔV budget for the lunar landing mission, are specified in Table 3.5-1.

The CM shall be the spacecraft command center for the performance of crew-initiated functions, except for LEM functions during LEM operations. The LEM ascent stage shall contain a command center for the performance of crew-initiated functions during LEM operations. An instrumentation subsystem shall be provided in the spacecraft which, in conjunction with the D&C subsystem, shall permit the crew and ground personnel to monitor and evaluate spacecraft performance. The spacecraft shall be capable of utilizing data from Earth-based tracking and computing facilities in conjunction with onboard computations. In addition, the spacecraft shall be capable of performing the mission or of aborting independent of ground facilities.

The spacecraft system shall be designed to accomplish the LOR mission at the design performance levels specified herein. Fourteen-day Earth orbital or lunar missions shall be possible by appropriate system management.

No equipment or components critical to the completion of the mission shall be dependent on the cabin atmosphere for electrical insulation or thermal conditioning. Only those materials which do not present a fire hazard or emit harmful quantities of atmospheric contaminants when exposed to an oxygen-enriched, low-pressure environment shall be used in the crew envelopes of the CM and LEM.

3.5.1.1 Prelaunch Environment During the prelaunch period, the spacecraft shall be capable of withstanding natural ground environment and winds as specified 3.4.2.

3.5.1.2 Prelaunch Checkout The spacecraft shall be designed to facilitate remote checkout during the prelaunch phase by automated equipment designed in accordance with the requirements of 3.6.2.

3.5.1.3 In-Flight Performance Evaluation The spacecraft shall be designed to facilitate in-flight system performance and status evaluation by the MCC.

3.5.1.4 Standby Time As a minimum, the spacecraft shall have the capability to stand by in a loaded condition after launch vehicle propellant loading, for the duration of the launch window and still perform the mission. The spacecraft shall have the capability to meet a launch window on each of three successive days.

3.5.1.5 Launch and Flight Environment The spacecraft shall be capable of being launched in the wind conditions specified in 3.4.2.2.

3.5.1.6 Earth Orbit Environment During the Earth orbit phase, the spacecraft shall be capable of operating in the terrestrial space environment as given in Section 3 of M-DE 8020.008B.

3.5.1.7 Translunar Environment During the translunar phases and lunar orbit operations, the spacecraft shall be capable of operating in the cislunar space environment as given in Section 4 of M-DE 8020.008B.

3.5.1.8 Transposition The CSM shall be capable of being repositioned from the launch configuration to the docked configuration within two hours after injection. After transposition, the spacecraft shall be capable of being separated from the S-IVB/IU and of avoiding impact with the S-IVB/IU during subsequent flight maneuvers.

3.5.1.9 One-Man Operation The spacecraft shall be designed so that a single crew member can perform all functions required to accomplish a safe return to Earth from any point in the mission. The CSM shall be designed so that during lunar operations a single crew member can perform all essential CSM operations for at least seven days. The LEM shall be designed so that a single crew member can perform all essential LEM operations during LEM phases.

3.5.1.10 CSM-LEM Abort The spacecraft shall be capable of utilizing the LEM descent propulsion as backup to SPS propulsion to the extent that LEM propellant supplies permit.

3.5.1.11 Separation Time All LEM subsystems shall be capable of meeting their performance requirements for a minimum of 48 hours while separated from the CSM.

3.5.1.12 Descent Abort The LEM ascent stage shall be capable of separating from the descent stage during descent, and of returning to lunar orbit.

3.5.1.13 Translational Range The LEM shall have the capability for a translational range of at least 1000 feet during hover above the lunar surface.

3.5.1.14 Lunar Environment During lunar operations including LEM landing and takeoff, all spacecraft subsystems exposed to the lunar surface environment shall be capable of operating in the environmental conditions given in 5.0 of M-DE 8020.008B.

3.5.1.15 Lunar Landing The LEM shall be capable of performing a controlled soft landing at any point in the landing area where the lunar surface characteristics fall within the range of the surface conditions given in 5.8 of M-DE 8020.008B. The lunar landing accuracy shall be as specified in 3.1.1.2.7.

3.5.1.16 Lunar Operations The capability shall be provided for a planned stay time of 35 hours on the lunar surface. The LEM shall be capable of utilizing the 9-hour contingency capability specified in 3.5.1.20 (c) to extend lunar stay time to 44 hours.

The LEM shall be capable of accommodating the temperatures of lunar day or lunar night as given in 5.7 of M-DE 8020.008B and as required by the appropriate mission appendix to this specification. The LEM subsystems shall be capable of supporting lunar exploration as specified in 3.1.1.2.8. It shall be capable of being left unoccupied with the cabin unpressurized on the lunar surface.

3.5.1.17 Scientific Equipment Support See 3.5.7

3.5.1.18 Sterilization Sterilization of the spacecraft shall not be required.

3.5.1.19 Launch Platform The descent stage shall be capable of being used as a launch platform by the ascent stage on the lunar surface. The ascent stage shall be capable of lunar liftoff when the LEM is tilted up to 30° from the local vertical.

3.5.1.20 Ascent Stage Operations The LEM ascent stage shall be capable of operation independent from the descent stage for at least the time required to perform the following operations:

(a) Prelaunch checkout on the lunar surface.

(b) Ascent, rendezvous and dock.

(c) Nine-hour contingency stay time in lunar orbit after launch any time from the lunar surface.

3.5.1.21 Rendezvous and Dock Both the LEM and CSM shall have the capability to rendezvous and dock with the other in lunar orbit.

3.5.1.22 Entry The CM shall be capable of controlled flight through the Earth's atmosphere (as given in 2.5 of M-DE 8020.008B) to any preselected impact point having a ground range between 1,500 nm and 2,500 nm from the entry point (defined as the point at which the vehicle first descends through the 400,000 feet altitude level). Additionally, the CM shall be capable of safe flight to all extended ranges between 2,500 nm and 3,500 nm. Both of these shall be possible without exceeding a 10g deceleration for inertial entry velocities up to 36,500 fps and equatorial inclinations between $\pm 90^{\circ}$. The design limit entry load for all CM systems shall be a 20g deceleration.

3.5.1.23 Aerodynamic Characteristics The CM shall have an offset center of gravity (cg) which will produce a lift-to-drag ratio of $0.34 \pm .04$ at Mach 6. The direction of the lift vector shall be controllable through the use of the attitude control subsystem.

3.5.1.24 Landing With two-thirds or more of the parachute area effective,

(a) The capability shall be provided for safe landing on water under conditions given in 2.6.2 of M-DE 8020.008B.

(b) The capability shall be provided for a survivable landing on land under conditions given in 2.6.1 of M-DE 8020.008B.

3.5.1.25 Postlanding The CM shall provide a survivable environment and provisions for the crew for two days after landing under environmental conditions given in 2.7 of M-DE 8020.008B. It shall be capable of floating in an apex-up, stable attitude for at least 48 hours and of remaining afloat for a total of at least seven days under environmental conditions given in 2.8 of M-DE 8020.008B.

3.5.1.26 Recovery The CM shall be equipped with recovery aids to assist recovery forces in locating it after landing and in effecting recovery of the crew and the vehicle.

3.5.2 Command and Service Modules

3.5.2.1 Structure

3.5.2.1.1 Cabin Space The CM cabin shall provide sufficient space to allow three crew members wearing pressurized suits to perform all functions required for crew safety and mission success.

3.5.2.1.2 Windows Window areas shall be provided to allow the CM crew to perform rendezvous and docking maneuvers with the LEM using direct visual means.

3.5.2.1.3 Ingress and Egress The structure shall be designed to permit the following:

(a) Intravehicular transfer of crew members between the docked CSM and LEM within the controlled environment.

(b) Egress to and ingress from space by crew members, including extravehicular transfer in either the docked or undocked configuration without assistance from any other crew member.

(c) Passage through all hatches by astronauts in inflated suits.

(d) Rapid emergency egress from the CM while on the launch pad.

3.5.2.1.4 Docking A docking mechanism which will provide a positive structural tie between the CM and LEM shall be provided.

3.5.2.1.5 Thermal Requirements Passive thermal control shall be provided to minimize heat transfer through the walls. Thermal designs may take advantage of change in spacecraft orientation, provided that there shall be no compromise of required operational flexibility.

3.5.2.1.6 Extravehicular Mobility Unit (EMU) Storage The CM will provide the capability of storing EMU components necessary for:

(a) Three crewmen to operate in a pressurized cabin.

(b) Three crewmen to operate in an unpressurized cabin.

(c) One crewman to conduct extravehicular operations.

3.5.2.2 CSM Propulsion

3.5.2.2.1 General Performance characteristics of the CSM propulsion subsystems shall be as specified in Table 3.5-1. The service life of propulsion subsystems after pre-mission testing shall allow the engines to be fired for sufficient time to deplete propellants available when all propellant tanks are loaded to the maximum capacity.

3.5.2.2.2 Command Module Reaction Control Subsystem The CM RCS shall provide thrust for attitude control of the CM about three axes after separation from the SM. There shall be two separate, redundant subsystems, each having provisions for dumping unburned propellant and venting the pressurizing gas prior to touchdown.

3.5.2.2.3 Service Module Reaction Control Subsystem The SM RCS shall provide thrust for attitude control about three axes when the spacecraft is in the CSM or CSM/LEM configuration. The SM RCS shall provide thrust for propellant settling for the SPS and thrust for small translational maneuvers. The SM RCS shall have four engine clusters, any two of which are sufficient to accomplish the mission.

TABLE 3.5-1

SPACECRAFT PROPULSION PERFORMANCE CHARACTERISTICS

	SPS	CM RCS	SM RCS	LEM ASCENT	LEM DESCENT	LEM RCS
Vacuum Thrust (lbs per thruster)	20,000 ±1%	88± 3.45	100 ±5%	3,500 ±2.5%	10,500± 3% to 1,050 (1)	100 ±5%
Vacuum Steady State Isp (sec) Nominal	315	274	280	309	309(100%F)	280
Vacuum Steady State Isp (sec) Minimum	313	266	275	306	305(100%F) 285(10%F)	275
Maximum Vacuum Impulse Bit (2) (lb-seconds)	5000±200	1 to 2	.5±.45		N/A	.5±.45
Propellant Combination	(3)	(4)	(3)	(3)	(3)	(3)
ΔV Allocations (fps)	3607 (LEM attached) & 3870(with-out LEM)	N/A	N/A	6150(5)	7332	436(5)
RCS Usable Propellant Tank Capacity (lbs)	N/A	225	790	N/A	N/A	575

(Numbers in brackets refer to notes below)

NOTES:
(1) Thrust controllable between 10,500 lbs and 1,050 lbs.
(2) Bit is defined as the minimum obtainable pulse.
(3) N_2O_4 with .45 to .85% NO by weight, UDMH/N_2H_4.
(4) N_2O_4 with .45 to .85% NO by weight, MMH.
(5) Additional capability must be provided to compensate for moment unbalance during ascent engine thrusting.

3.5.2.2.4 Service Module Propulsion Subsystem The SPS shall provide thrust for translational maneuvers of the spacecraft in both the CSM and CSM/LEM configurations. The SPS shall be capable of providing thrust for abort maneuvers from the separation of the LES until entry.

3.5.2.3 CSM Communications and Tracking

3.5.2.3.1 General The CSM Communication and Tracking System shall provide the following capabilities:

(a) Voice communications.

(b) Telemetry transmission and reception.

(c) Tracking aid.

(d) Up-data reception.

(e) Television transmission.

(f) Recovery beacon transmission.

3.5.2.3.2 Functional Capability

3.5.2.3.2.1 Voice Communications The voice communication subsystem shall be able to provide 2-way voice communication between:

(a) Crew members in the pressurized or the unpressurized CM.

(b) The CSM and one or two extravehicular astronauts (EVA).

(c) The CSM and LEM in both the separated and the docked configurations.

(d) The MSFN and three astronauts in the CSM.

(e) An EVA (near the CSM) and the MSFN using the CSM as a relay.

(f) The CSM, LEM and MSFN both as a conference loop and with one acting as a relay for the other two.

(g) The CSM and the launch complex prior to liftoff.

(h) The CM and the recovery forces.

Manually-keyed transmission from the CSM to the MSFN shall be provided as an emergency backup.

The voice communication subsystem shall be able to record and transmit recorded CSM voice communications to the MSFN without interrupting normal voice communications.

3.5.2.3.2.2 Telemetry The telemetry subsystem shall be able to:

(a) Transmit operational data from the CSM to the MSFN at a high and low bit data rate.

(b) Transmit scientific data from the CSM to the MSFN.

(c) Transmit instrumentation and biomedical data from an EMU during checkout in the CSM to the MSFN.

(d) Receive instrumentation and biomedical data from an EVA (near the CSM), and transmit this data to the MSFN.

(e) Receive and record, in the CSM, low bit rate telemetry from the LEM.

(f) Transmit recorded telemetry data at the high bit rate simultaneously with the CSM operational data.

3.5.2.3.2.3 Tracking Aid The tracking aid subsystem shall enable:

(a) The MSFN to track the CSM.

(b) The LEM to track the CSM.

3.5.2.3.2.4 Up-Data The up-data subsystem shall be able to:

(a) Receive data from the MSFN.

(b) Provide, in conjunction with the PNGCS, for the display of up-data addressed to the digital guidance computer.

(c) Supply up-data verification signals to the MSFN via the CSM telemetry subsystem.

3.5.2.3.2.5 Television The television subsystem shall be able to transmit television pictures to the MSFN.

3.5.2.3.2.6 Recovery Beacon Continuous beacon operation from the CM shall be provided for at least two days after touchdown.

3.5.2.3.3 Coverage Capability

3.5.2.3.3.1 CSM-MSFN The CSM Communication and Tracking System shall be able to operate with the MSFN to achieve the coverage specified in Table 3.7-1.

3.5.2.3.3.2 CSM-LEM The following line-of-sight communications and tracking coverage between the CSM and the LEM shall be provided:

(a) Two-way voice communications from the docked position to a range of 550 nm.

(b) CSM reception of telemetry from the LEM whenever the LEM is within a range of 300 nm.

(c) LEM tracking of the CSM tracking aid whenever the CSM is within a range of 400 nm.

3.5.2.3.3.3 CSM-EVA The CSM shall be able to:

(a) Maintain continuous 2-way voice communications with one or two EVA's.

(b) Receive continuous EMU telemetry from an EVA.

Both requirements shall be met for ranges up to 1 nm.

3.5.2.3.4 Performance The CSM Communication and Tracking System shall meet the requirements specified in Tables 3.5-2A and 3.5-2B.

3.5.2.4 Electrical Power Subsystem

3.5.2.4.1 General The CSM Electrical Power Subsystem (EPS) shall generate and distribute all the electrical power required by the CSM during all phases of a 14-day mission plus 48 hours of the post-landing recovery period. In addition, the CSM EPS shall be capable of supplying power to the LEM during the translunar and lunar orbit phases. Until SM separation, the primary source of electrical power shall be fuel cells. After SM separation, CM power shall be supplied by batteries.

3.5.2.4.2 Nominal Capacity The EPS shall utilize three liquid hydrogen and liquid oxygen fuel cells, and shall be capable of supplying a total of 575 kwh of electrical energy. Each fuel cell shall be capable of supplying power over a range from 565 watts to 1400 watts. The EPS shall be capable of recharging the entry and postlanding batteries.

3.5.2.4.3 Sizing In the event of the failure of one fuel cell, the remaining two cells shall have sufficient capacity to continue the normal mission, assisted by storage batteries. In the event of the failure of two fuel cells, the remaining cell when assisted by storage batteries shall have the capacity to supply all essential power for a period sufficient to return the crew safely to Earth from any phase of the mission.

3.5.2.4.4 Water and Oxygen Supply The EPS shall be the primary source of potable water and oxygen for crew consumption.

3.5.2.4.5 Pyrotechnic Firing Circuits There shall be redundant means for firing all pyrotechnic devices. All pyrotechnic firing circuits shall be isolated from the main electrical subsystems.

3.5.2.4.6 Ground Support The EPS shall be capable of distributing power from an external source during the prelaunch phase.

3.5.2.5 Integrated Navigation, Guidance and Control System

3.5.2.5.1 General The integrated navigation, guidance and control system shall be composed of the CM Primary Navigation, Guidance and Control System (PNGCS) and the CM Stabilization and Control System (SCS) with common usage of some elements. These systems used in conjunction with data from the MSFN, shall provide a redundant navigation, guidance and control capability. Table 3.5-3 shows the functions that shall be provided by the PNGCS and SCS.

The PNGCS shall provide the capability for the navigation, guidance and control functions during normal missions and those aborted

TABLE 3.5-3

Functions	Vehicle Configurations			
	S-IVB/IU CSM/LEM	CSM/LEM	CSM	CM
Thrust Vector Control of the SPS		P, S	P, S	
Attitude Control	P	P, S	P, S	P, S
Translation Control using Reaction Control System	P	P, S	P, S	
Navigation and Guidance	P	P, S*	P, S*	P
Lift Vector Control				P, S

P indicates function required of PNGCS
S indicates function required of SCS

*The SCS requires navigational data from the MSFN in order to perform this function.

missions not involving failure of the PNGCS. The PNGCS shall be capable of providing its functions independent of data or commands from sources external to the spacecraft, and it shall be capable of utilizing navigational data supplied by the MSFN. The SCS, using navigational data received from the MSFN, shall provide the capability for returning the CM to Earth in the event of failure of the PNGCS.

3.5.2.5.1.1 The principal elements of the PNGCS shall be an IMU, a digital computer, an optical subsystem and the displays and controls needed for crew operation.

3.5.2.5.1.2 The principal elements of the SCS shall be gyroscopes and an accelerometer rigidly mounted to the CM structure, control electronics and the displays and controls needed for crew operation.

3.5.2.5.1.3 The PNGCS shall be capable of providing guidance and control commands to the launch vehicle to accomplish the functions required in 3.4.4.1.2 for the Saturn V and 3.3.4.1.2 for the Saturn 1B.

3.5.2.5.1.4 The PNGCS and the SCS shall:

(a) Provide displays and controls to permit normal crew operation and performance monitoring of the systems. This includes such functions as selection of modes of operation, insertion of operating commands or data into the digital computer, entry monitoring and initiation of automatic operations.

(b) Provide their functions automatically, once initiated, except for the SCS functions of translation control using the SM RCS and lift vector control.

(c) Provide means to permit the crew to assume manual control of the spacecraft. Included shall be the capability of manual attitude and thrust vector control and manual start-stop control of the SPS engine.

(d) Include a means for checkout on the launch pad utilizing the prelaunch checkout equipment. Means shall also be provided for in-flight checkout and failure detection.

3.5.2.5.1.5 The PNGCS shall:

(a) Provide the crew with the capability, through the use of the optical subsystem, of making sightings on Earth and lunar landmarks and on celestial bodies for:

(1) Prelaunch and in-flight alignment of the PNGCS IMU.

(2) Alignment of the SCS inertial attitude reference.

(3) Navigation.

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(b) Have a mode of operation which, once set up by the crew, will permit the guidance, navigation and control functions to be commanded by the ground without further crew participation.

(c) Have a mode of operation which will permit the digital computer to accept commands and data from the MSFN via the updata link.

(d) Provide navigation, guidance and control capability for CSM rescue of the LEM while in a lunar parking orbit.

(e) Be capable of monitoring the position, velocity, attitude and attitude rates of the Apollo space vehicle during all burns of the S-IC, S-II and S-IVB stages.

(f) Enable the crew to align the PNGCS IMU and SCS inertial attitude reference during the mission.

3.5.2.5.2 Accuracy The accuracy of the PNGCS for translunar injection shall be the same as specified in 3.4.4.2. The integrated navigation, guidance and control system, when used with the MSFN, shall be capable of correcting for the translunar injection errors specified in 3.4.4.2 with midcourse corrections not exceeding 200 ft/sec.

The PNGCS shall be capable of guiding the CM during entry to the preselected point of parachute deployment within a 10-nm CEP.

3.5.2.6 Display and Control Subsystem

3.5.2.6.1 General The Display and Control (D&C) subsystem shall accept information from the instrumentation subsystem, and shall display it in such a manner that the crew can assess the current status and trends of critical subsystems. The D&C subsystem shall provide controls for crew operation of the spacecraft.

3.5.2.6.2 Warning Indicators The D&C subsystem shall provide active warning indicators for out-of-tolerance conditions in critical subsystems.

3.5.2.6.3 Launch Vehicle Emergencies Incipient critical failures in launch vehicle subsystems detected by the Emergency Detection Subsystem shall be displayed.

3.5.2.6.4 One-Man Operation The subsystem design shall allow for performance of all critical control functions by one crew member in a pressurized suit.

3.5.2.6.5 Manual Override Manual override or inhibit capability shall be provided on all automatic subsystems.

3.5.2.6.6 CSM-LEM Compatibility Similarity between controls and displays in the LEM and in the CM shall exist whenever practicable.

3.5.2.7 Environmental Control Subsystem The CSM shall be equipped with a nonregenerative Environmental Control Subsystem (ECS) which shall provide a conditioned atmosphere, thermal control and water management in support of the crew with and without pressure suits. The ECS shall also provide thermal control of equipment where needed.

3.5.2.7.1 Atmospheric Supply The CSM crew compartment shall be supplied with pure oxygen. Referenced to 70° F dry bulb, the partial pressure of oxygen shall not be less than 180 mm Hg and, after the boost phase, shall not exceed 300 mm Hg. The primary source of oxygen to meet the physiological requirements of the crew shall be the EPS located in the SM. The ECS shall be capable of maintaining a cabin pressure of not less than 3.5 psia for at least 15 minutes following a 0.25-inch diameter puncture. This capability shall not be required in the CM after SM separation. The ECS shall provide stored oxygen in the CM for use from SM separation to CM touchdown.

3.5.2.7.1.1 Atmospheric Control Provisions shall be made for control of temperature, ventilation rates and humidity within the range necessary to:

(a) Maintain the crew in biothermal equilibrium with sweat rates not exceeding safe physiological limits.

(b) Preclude condensation on any surface interior to the crew compartment which will impair equipment operation or crew performance.

Provisions shall be made for limiting the concentration of toxic and noxious gases and particulate matter to below those levels capable of causing equipment malfunction or impaired crew performance.

3.5.2.7.2 Water Management The primary source of potable water for the CSM ECS shall be the EPS. Arrangements shall be made for storing waste water separately.

3.5.2.7.3 EMU Support The ECS shall be capable of providing continuous intravehicular support to three astronauts in pressurized suits for the period required to return the crew safely to Earth from any point in the mission. The design to meet this requirement shall be based upon an average energy expenditure of 500 BTU's/man/hour and a Respiration Quotient of 0.85.

3.5.2.8 Crew Equipment

3.5.2.8.1 General The CSM shall contain provisions and equipment necessary to protect and sustain the crew. Support shall be provided, beginning with crew occupancy of the CSM during the prelaunch phase and ending with crew recovery at completion of the mission.

3.5.2.8.2 Support and Restraint The support and restraint subsystem shall provide crew protection against injury for all anticipated accelerations.

3.5.2.8.3 Illumination Provisions shall be made for control of illumination to facilitate accurate reading of instrumentation, adjustments to equipment and operation of controls under any external lighting conditions which may be encountered during the mission.

3.5.2.8.4 Food and Water The CSM shall be designed to accommodate quantities of food and potable water adequate for 42 man-days of flight operation based on a metabolic rate of 11,200 BTU's/man/day and a Respiration Quotient of 0.85. The design shall provide for:

(a) Control of bacterial growth during storage.

(b) Oral ingestion of food and water by crew members in pressurized suits.

The composition of food shall result in a low-bulk residue which is free from detrimental waste products. The water management shall be provided as specified in 3.5.2.7.2.

3.5.2.8.5 Waste Management Provisions shall be made for the collection and disinfection of biological excretions.

An effective method of confinement or sterilization shall be employed to ensure that untreated biological waste does not become free residue in space.

3.5.2.8.6 Medical Supplies The first aid equipment, drugs and medical supplies provided shall be compatible with the crew, equipment, other supplies and the environment.

3.5.2.8.7 Biomedical Instrumentation Instrumentation shall be provided to monitor the physiological parameters of each crewman as given in MSF Instruction, MIM 7000.029.

3.5.2.8.8 Survival Survival equipment and provisions shall be provided to sustain the crew, independent of the CM, for seven days after landing.

3.5.3 Lunar Excursion Module

3.5.3.1 Structure

3.5.3.1.1 Cabin Space The LEM cabin shall provide sufficient space for two crew members wearing pressurized suits and allow either one or both to perform all functions required for crew safety and mission success.

3.5.3.1.2 Windows Window areas shall be provided to allow the LEM crew to perform rendezvous and docking with the CSM and lunar landing using direct visual means.

3.5.3.1.3 Ingress and Egress The structure shall be designed to permit the following:

(a) Intravehicular transfer of crew members between the docked LEM and CSM within the controlled environment.

(b) Egress to and ingress from space by crew members, including extravehicular transfer in either the docked or undocked configuration without assistance from another crew member.

(c) Egress from and ingress to the LEM when it is on the lunar surface, without assistance from another crew member.

(d) Passage through all hatches by crewmen in inflated pressure garment assemblies.

3.5.3.1.4 Docking A docking mechanism which furnishes a positive structural tie between the LEM and CSM shall be provided.

3.5.3.1.5 Thermal Requirements Passive thermal control shall be provided to minimize heat transfer through the walls. Thermal designs may take advantage of change in spacecraft orientation, provided that there shall be no compromise of required operational flexibility.

3.5.3.1.6 EMU Storage The LEM shall provide the capability of storing EMU components necessary for:

(a) Two crewmen to operate in a pressurized cabin.

(b) Two crewmen to operate in an unpressurized cabin.

(c) Two crewmen to conduct simultaneous extravehicular operations.

3.5.3.2 LEM Propulsion

3.5.3.2.1 General Performance characteristics of the LEM propulsion subsystems shall be as specified in Table 3.5-1. The service life of propulsion subsystems after pre-mission testing shall allow the engines to be fired for sufficient time to deplete propellants available when all propellant tanks are loaded to the maximum capacity.

3.5.3.2.2 LEM Reaction Control Subsystem The LEM RCS shall provide thrust for translation along three axes and attitude control about three axes during rendezvous, docking, descent and ascent phases. There shall be two separate, redundant subsystems. Propellant shall be transferable from the LEM ascent stage main propellant tanks to the LEM RCS engines.

3.5.3.2.3 LEM Descent Propulsion Subsystem The LEM descent propulsion subsystem shall provide thrust to transfer the LEM from lunar parking orbit to the lunar surface, including descent and hover close to the lunar surface.

3.5.3.2.4 LEM Ascent Propulsion Subsystem The LEM ascent propulsion subsystem shall provide thrust for launching the LEM ascent stage from the lunar surface and transferring it into lunar orbit for CSM rendezvous. It shall be capable of providing the thrust required for abort during the lunar descent phase.

3.5.3.3 LEM Communications and Tracking

3.5.3.3.1 General The LEM Communication and Tracking System shall provide the following capabilities:

(a) Voice communications.

(b) Telemetry transmission and reception.

(c) Tracking and tracking aid.

(d) Television transmission.

3.5.3.3.2 Functional Capability

3.5.3.3.2.1 Voice Communication The voice communication subsystem shall be able to provide 2-way voice communications between:

(a) Crew members in the LEM.

(b) LEM and an EVA.

(c) CSM and LEM in both the separated and the docked configurations.

(d) MSFN and two astronauts in the LEM.

(e) CSM, LEM and MSFN both as a conference loop and with one acting as a relay for the other two.

(f) One or two EVA's and MSFN using the LEM as a relay.

Manually-keyed transmission from the LEM to the MSFN shall be provided as an emergency backup.

3.5.3.3.2.2 Telemetry The telemetry subsystem shall be able to:

(a) Transmit operational data from the LEM to the MSFN at a high and low bit data rate.

(b) Transmit instrumentation and biomedical data from the EMU during checkout in the LEM to the MSFN.

(c) Receive instrumentation and biomedical data from an EVA (near the LEM) and transmit this data to the MSFN.

(d) Transmit low bit rate telemetry to the CSM.

3.5.3.3.2.3 Tracking and Tracking Aid The tracking and tracking aid subsystem shall enable:

(a) MSFN to track the LEM.

(b) LEM to track the CSM.

(c) LEM to measure the velocity and range of the LEM relative to the lunar surface or to a tracking aid on the lunar surface during the descent to the lunar surface.

3.5.3.3.2.4 Television The television subsystem shall be able to transmit television pictures from the lunar surface to the MSFN.

3.5.3.3.3 Coverage Capability

3.5.3.3.3.1 LEM-MSFN The LEM Communication and Tracking System shall be able to operate with the MSFN to achieve the coverage specified in Table 3.7-2.

3.5.3.3.3.2 LEM-CSM The following line-of-sight communication and tracking coverage between the LEM and the CSM shall be provided:

(a) Two-way voice communications from the docked position to a range of 550 nm.

(b) LEM transmission of telemetry to the CSM whenever the CSM is within a range of 300 nm.

(c) LEM tracking of the CSM whenever the CSM is within a range of 400 nm except during LEM main engine powered maneuvers.

3.5.3.3.3.3 LEM-EVA The LEM shall be able to:

(a) Maintain a continuous 2-way voice communication capability with one or two EVA's.

(b) Receive continuous EMU telemetry from an EVA.

Both requirements shall be met for line-of-sight ranges of 3 nm on the lunar surface or 1 nm during flight.

3.5.3.3.3.4 LEM-Lunar Surface The tracking subsystem shall be able to supply data to the LEM guidance and navigation system from an altitude of 25,000 feet above the lunar surface when working without a tracking aid on the surface and from a range of 20 nm from a tracking aid.

3.5.3.3.4 Performance The LEM Communication and Tracking System shall meet the requirements specified in Tables 3.5-4A and 3.5-4B

3.5.3.4 Electrical Power Subsystem

3.5.3.4.1 General The LEM Electrical Power Subsystem (EPS) shall distribute all the electrical power required by the LEM during all phases of a 14-day mission up to the abandoning of the LEM. The primary source of power shall be EPS batteries located in the ascent and descent stages. In addition, the LEM EPS shall be capable of distributing power supplied to the LEM by the CSM during the translunar and lunar orbit phases. The LEM EPS shall provide the power required by the scientific equipment as specified in 3.5.7.

3.5.3.4.2 Sizing The power generation subsystem shall contain four descent-stage batteries and two ascent-stage batteries. In the event of failure of one ascent-stage battery the remaining ascent-stage battery, in conjunction with any remaining descent-stage capacity, shall have the capability of supplying all essential power loads for a period sufficient to allow the LEM to return safely from any phase of the mission to the CSM in lunar orbit.

3.5.3.4.3 Nominal Capacity The EPS shall be capable of generating 45 kwh of electrical energy from the descent-stage batteries at a maximum rate of 3900 watts and 17 kwh of electrical energy from the ascent-stage batteries at a maximum rate of 3200 watts.

3.5.3.4.4 Pyrotechnic Firing Circuits There shall be redundant means for firing all pyrotechnic devices. All pyrotechnic firing circuits shall be isolated from the main electrical subsystems.

3.5.3.4.5 Ground Support The EPS shall be capable of distributing power from an external source during the prelaunch phase.

3.5.3.5 Integrated Navigation, Guidance and Control System

3.5.3.5.1 General The integrated navigation, guidance and control system shall be composed of the LEM Primary Navigation Guidance and Control System (PNGCS) and the LEM Stabilization and

Control System (SCS) with common usage of some elements. These systems shall provide a redundant navigation, guidance and control capability.

The PNGCS and the SCS shall be capable of providing the following functions for the LEM independent of data or commands from sources external to the LEM.

(a) Navigation and guidance.

(b) Attitude control using the LEM RCS.

(c) Translation control using the LEM RCS.

(d) Thrust control and thrust vector control for the descent stage.

The PNGCS shall provide the capability for the navigation, guidance and control functions during normal missions and those aborted missions not involving failure of the PNGCS. The SCS shall provide the capability of returning the LEM to lunar parking orbit in the event of failure of the PNGCS.

3.5.3.5.1.1 The principal elements of the PNGCS shall be an IMU, a digital computer, an optical subsystem and the displays and controls needed for crew operation.

3.5.3.5.1.2 The principal elements of the SCS shall be gyroscopes and acclerometers rigidly mounted to the LEM structure, guidance electronics, control electronics and the displays and controls needed for crew operation.

3.5.3.5.1.3 The LEM PNGCS and SCS shall:

(a) Provide displays and controls to permit normal crew operation and performance monitoring of the systems. This includes such functions as selection of modes of operation, insertion of operating commands or data into the digital computer and initiation of automatic operations.

(b) Provide their functions automatically, once initiated, except for SCS translation control using the LEM RCS.

(c) Provide means to permit the crew to assume manual control of the LEM. Included shall be the capability of attitude control, start-stop control of the LEM engines, and thrust vector and thrust magnitude control of the descent engine.

(d) Include a means for checkout on the launch pad, utilizing the prelaunch checkout equipment. Means shall also be provided for in-flight checkout and failure detection.

3.5.3.5.1.4 The PNGCS shall:

(a) Be capable of utilizing navigational data from the LEM rendezvous radar.

(b) Be capable of utilizing navigational data (altitude above the lunar surface and velocity of the LEM relative to the surface) from the LEM landing radar.

(c) Have a mode of operation which permits descent from the lunar orbit and soft landing at a preselected landing point on the lunar surface without the participation of the LEM crew except for alignment of the LEM IMU.

(d) Provide the means so that the crew can make optical sightings on celestial bodies for alignment of the PNGCS and SCS inertial attitude references, both in flight and on the lunar surface.

(e) Provide means for the crew to redesignate the landing site during powered descent.

(f) Enable the crew to align the PNGCS IMU and SCS inertial attitude reference during the mission.

(g) Be capable of providing guidance to the spacecraft (CSM-LEM) when using LEM descent propulsion as back-up to the SPS propulsion (See 3.5.1.10).

3.5.3.5.2 Accuracy Independent of lunar-based landing aids, the PNGCS shall be capable of guiding the LEM to a preselected landing site with a CEP of 0.5 nm, and with the use of a lunar-based landing aid with a CEP of 100 ft.

3.5.3.6 Display and Control (D&C) Subsystem The requirements for the LEM D&C subsystem are the same as those for the CSM D&C subsystem specified in 3.5.2.6, except that 3.5.2.6.3 shall be deleted.

3.5.3.7 Environmental Control Subsystem The LEM shall be equipped with a nonregenerative ECS which shall provide a conditioned atmosphere, thermal control and water management in support of the crew in pressurized and unpressurized suits. The ECS shall also provide thermal control of equipment where needed.

3.5.3.7.1 Extravehicular Operations The LEM ECS shall be designed to support a total of 24 hours of extravehicular operations on the lunar surface consistent with the requirements specified in 3.1.1.2.8 and 3.5.6.2.

3.5.3.7.2 Atmospheric Supply The LEM crew compartment shall be supplied with pure oxygen. During LEM manned phases, except for ingress and egress operations, the partial pressure of oxygen shall not be less than 180 mm Hg and shall not exceed 300 mm Hg referenced to 70°F dry bulb. The ECS shall be capable of maintaining a cabin pressure not less than 3.5 psia for at least 2 minutes following a 0.5-inch diameter puncture.

3.5.3.7.2.1 Atmospheric Control Provisions shall be made for control of temperature, ventilation rates and humidity within the range necessary to:

(a) Maintain the crew in biothermal equilibrium with sweat rates not exceeding safe physiological limits.

(b) Preclude condensation on any surface interior to the crew compartment which will impair equipment operation or crew performance.

Provisions shall be made for limiting the concentration of toxic and noxious gases and particulate matter to below those levels capable of causing equipment malfunction or impaired crew performance.

3.5.3.7.3 Water Management The primary source of potable water for the LEM ECS shall be water stored onboard at launch. Arrangements shall be provided for storing waste water separately.

3.5.3.7.4 EMU Support The ECS shall incorporate arrangements to provide intravehicular support for two astronauts in pressurized suits for a continuous period consistent with the requirements of 3.5.1.20. The design shall be based on an energy expenditure not exceeding 800 BTU's/man/hour and a Respiration Quotient of 0.85.

3.5.3.8 Crew Equipment

3.5.3.8.1 General The LEM shall contain provisions and equipment necessary to protect and sustain the crew. The support period shall cover the time required for checkout of the LEM plus 48 hours of separate LEM operation.

3.5.3.8.2 Support and Restraint The support and restraint subsystem shall provide crew protection against injury for all anticipated accelerations.

3.5.3.8.3 Illumination Provisions shall be made for control of illumination to facilitate accurate reading of instrumentation, adjustments to equipment and operation of controls under any external lighting conditions which may be encountered during LEM checkout and operations.

3.5.3.8.4 Food and Water The LEM shall be designed to accommodate quantities of food and potable water adequate for four man-days operation based on a metabolic rate of 18,000 BTU's/man/day and a Respiration Quotient of 0.85. The design shall provide for: (a) control of bacterial growth during storage, and (b) oral ingestion of food and water by crew members in pressurized suits. The composition of food shall result in a low-bulk residue which is free from detrimental waste products. The water management shall be provided as specified in 3.5.3.7.3.

3.5.3.8.5 Waste Management Provisions shall be made for the collection and disinfection of biological excretions. An effective method of confinement or sterilization shall be employed to ensure that untreated biological waste does not become free residue in space or on the lunar surface.

3.5.3.8.6 Medical Supplies The first aid equipment, drugs and medical supplies provided shall be compatible with the crew, equipment, other supplies and the environment.

3.5.3.8.7 Biomedical Instrumentation Instrumentation shall be provided to monitor the physiological parameters of each crewman as given in MSF Instruction MIM 7000.029.

3.5.4 Launch Escape System

3.5.4.1 The LES shall be capable of removing the CM from a malfunctioning space vehicle and providing sufficient separation distance to ensure crew safety without exceeding astronaut tolerances or the structural limit of the CM/LES. It shall provide terminal conditions for the CM which permit safe entry into the lower atmosphere and deployment of the Earth Landing System (ELS).

3.5.4.2 The LES shall provide abort capability from crew entry into the CM until shortly after second stage ignition when the LES shall be jettisoned. The LES shall be capable of separating from the space vehicle during a normal mission without degrading space vehicle performance.

3.5.5 Adapter

3.5.5.1 General The Adapter shall structurally and functionally adapt the spacecraft to the launch vehicle and provide a protective housing for the LEM.

3.5.5.2 Access The Adapter shall be designed to provide access to the LEM during the prelaunch phase.

3.5.5.3 Deployment The Adapter shall be designed to permit CSM/Adapter separation, docking and extraction of the LEM, and shall not interfere with launch vehicle or spacecraft communications.

3.5.6 Extravehicular Mobility Unit

3.5.6.1 General EMU's of anthropomorphous design shall be provided for the crew. Each EMU shall incorporate the features of protection, life support, communications, visibility and mobility to accomplish the requirements specified in 3.1.1.2.8. The EMU's shall be designed to work in conjunction with the ECS as specified in 3.5.2.7 and 3.5.3.7.

3.5.6.2 Extravehicular Each EMU shall provide to a single crewman the capability for 4 hours continuous separation from spacecraft modules while in space or on the lunar surface. The time to completely replenish one EMU from LEM supplies shall not exceed 1 hour. The EMU's shall permit two crewmen to be extravehicular at the same time, and shall provide the capability for a total of 24 hours extravehicular operations when supported by the LEM ECS as specified in 3.5.3.7.1. During extravehicular operations, each EMU shall:

(a) Provide protection against the natural environment as given in 3.0, 4.0 and 5.0 of M-DE 8020.008B.

(b) Provide life support and mobility based on an average energy expenditure of 1200 BTU's/man/hour and a Respiration Quotient of 0.85.

(c) Provide the capability for communications with the CSM as specified in 3.5.2.3, and the LEM as specified in 3.5.3.3.

(d) Provide the capability for voice communication with another extravehicular astronaut.

(e) Permit ingress and egress through all spacecraft hatches.

3.5.6.3 Intravehicular In conjunction with spacecraft systems, the EMU's shall provide intravehicular support to the crew in an unpressurized cabin for the period required to return safely to Earth from any point in the mission. During intravehicular operations, each EMU shall:

(a) Provide the communications capability specified in 3.5.2.3 and 3.5.3.3.

(b) Provide the capability for each of three crewmen to simultaneously don the pressure protection components within 15 minutes without assistance from, or interference to, the other crew members while the spacecraft is in a stabilized mode.

3.5.7 Scientific Payload The scientific payload shall be designed to endure and operate in the environments of the lunar mission as stated in 3.0, 4.0 and 5.0 of M-DE 8020.008B.

The scientific payload to be returned to Earth by the CM shall not exceed 80 pounds.

The scientific payload carried in the LEM to the lunar surface shall not exceed 250 pounds and shall not require more than 2,400 watt-hours D.C. of LEM-supplied energy. The peak load shall not exceed 1,000 watts D.C.

The scientific payload to be returned from the lunar surface to lunar orbit by the LEM shall not exceed 80 pounds.

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3.5.8 Flight Crew Training Equipment The flight crew training equipment shall be designed to:

(a) Facilitate the attainment and maintenance of the crew skills necessary to assure the effective, reliable and safe operation of the space vehicle and its subsystems in both normal and contingency modes of operation for the entire mission.

(b) Allow the crew to develop the scientific and technical competence required to understand the principles of operation of the space vehicle, to assist in evaluation and development of the space vehicle, to understand and perform scientific experiments in space and on the lunar surface.

(c) Familiarize and condition the crew to the environments of space flight and lunar operations including contingency situations.

(d) Permit evaluation of crew proficiency.

Existing facilities and equipment, or facilities and equipment procured for development, testing, or operational phases of the Program shall be utilized to meet the training requirements whenever practicable.

Additional requirements for flight crew training equipment are contained in Section 15.4 of the Apollo Program Development Plan, NPC C500.

3.6 Launch Area

3.6.1 General

3.6.1.1 The launch area shall consist of the Launch Complexes 34, 37 and 39, and the direct launch support facilities for these launch complexes. Launch Complex 34 (LC 34) and Launch Pad B of Launch Complex 37 (LC 37B) shall provide the capability for launching the Saturn IB. Launch Complex 39 (LC 39) shall provide the capability for launching the Saturn V.

3.6.1.2 The direct launch support facilities shall include: The Operations and Checkout Building and associated facilities where the Apollo spacecraft shall be prepared for mating with either the Saturn IB or Saturn V launch vehicle; the Central Instrumentation Facility (CIF) which shall provide centralized instrumentation and data processing support; and the Central Telephone Office which shall provide the switching for communications required among facilities of the launch area and between the launch area and other NASA centers.

3.6.1.3 In addition to the direct launch support facilities specified here, the ETR shall be relied on to provide services to the launch area in accordance with the "Webb-McNamara Agreement," dated January 17, 1963.

3.6.1.4 The launch area shall be capable of supporting the Apollo Saturn IB and Apollo Saturn V launch-rate requirements as specified in the Apollo Flight Mission Assignments document, M-D MA 500-11.

3.6.2 Space Vehicle Checkout Systems Launch Complexes 34, 37, and 39 and the Operations and Checkout Building shall utilize checkout equipment capable of effecting independent checkout of the spacecraft and the launch vehicle and of performing compatible concurrent spacecraft and launch vehicle operations effecting automated checkout of Apollo Saturn IB and Apollo Saturn V space vehicles. As far as possible, the checkout equipment for the Apollo Saturn IB shall be identical to that to be used for the Apollo Saturn V. In addition, the spacecraft and launch vehicle checkout systems shall:

(a) Provide automatic, semi-automatic and manual modes of operation with provisions for manual intervention of automated routines.

(b) Utilize general purpose digital computers capable of adapting to possible hardware and parameter changes.

(c) Be capable of comparing measured data on a real time basis against predetermined limits to provide out-of-tolerance indications and warning of hazardous space vehicle conditions.

(d) Make maximum use of space vehicle telemetry systems to conduct preflight checkout.

(e) Incorporate a self-test and verification capability.

(f) Be capable of verifying system integrity through the use of hardware or software simulators prior to use on flight hardware.

(g) Provide the capability for recording digital and analog data for immediate recall or use in postflight analysis.

3.6.3 Launch Complexes 34 and 37B LC 34 and 37B shall include three major items: the launch pad and umbilical tower, the service structure and the Launch Control Center (LCC).

LC 37B shall provide the capability for on-pad assembly, preparation and launch of manned and unmanned Apollo Saturn IB space vehicles that include the LEM. LC 34 shall provide the same capability except LEM capability is not required.

The capability shall be provided to continue those services and operations necessary to support a launch hold of up to 12 hours occurring after completion of propellant loading.

LC 34 and 37B shall be designed to permit the launching of an Apollo Saturn IB during the 95 percentile peak surface wind conditions given in 2.3.2.3 of M-DE 8020.008B.

3.6.3.1 Launch Pad and Umbilical Tower The launch pad and umbilical tower shall receive the space vehicle and provide support to the space vehicle during assembly, preparation, checkout and launch.

The launch pad and umbilical tower shall provide for:

(a) Automated checkout of the space vehicle in conjunction with equipment located in the LCC and the Operations and Checkout Building.

(b) Applying servicing lines to the space vehicle.

(c) Ingress to and egress from the CM.

(d) Rapid emergency egress from the vicinity of a malfunctioning space vehicle.

(e) Protection of the space vehicle and umbilical tower support systems from lightning damage whenever the service structure is not in place at the launch pad.

3.6.3.2 Service Structure The service structure shall provide:

(a) Personnel access and means for erecting and servicing the space vehicle.

(b) Protection for the space vehicle during maximum peak surface wind conditions given in paragraph 2.3.2.2 of M-DE 8020.008B. The service structure shall be capable of moving to a safe distance from the launch pad prior to launch.

(c) Protection of the space vehicle and service structure support systems from lightning damage whenever the service structure is in place at the launch pad and protection of service structure support systems at all other times.

3.6.3.3 Launch Control Center The LCC shall provide the capability for:

(a) Centralized control and monitoring of space vehicle test operations, countdown, launch and early flight phases.

(b) Continuous evaluation of the status of the launch complex and the space vehicle.

(c) Display of spacecraft status data received from the Operations and Checkout Building.

(d) Supplying status information to Huntsville Operations Support Center (HOSC) and the MCC.

(e) Transmitting EDS data, checkpoint status data, countdown timing and checkout priority information to the Operations and Checkout Building.

(f) Supporting in-flight checkout of S-IVB/IU in Earth orbit.

3.6.4 Launch Complex 39 LC 39 shall include the following major items: the Vertical Assembly Building (VAB); the Launcher-Umbilical Tower (LUT); the Crawler Transporter; the launch pads; the Arming Tower and the Launch Control Center (LCC).

LC 39 shall be constructed in accordance with a "mobile concept" of launch operations, embodying the basic principle of vertical assembly and checkout of the Apollo Saturn V in the VAB aboard a LUT and transfer of the space vehicle in an erect position to the launch pads.

LC 39 shall have the capability for:

(a) Preparing and launching manned and unmanned Apollo Saturn V space vehicles.

(b) Supporting a launch for the duration of the launch window.

(c) Continuing those services and operations necessary to allow a launch during the comparable launch window on the day following a launch hold.

3.6.4.1 Vertical Assembly Building The VAB shall have the capability for:

(a) Receiving, handling and supporting the individual launch vehicle stages, IU and assembled spacecraft.

(b) Vertical assembly of the complete Apollo Saturn V space vehicle aboard the LUT in a protected and controlled environment.

(c) Automated testing, verification and checkout of the space vehicle by equipment located in the LCC and the Operations and Checkout Building.

3.6.4.2 Launcher-Umbilical Tower The LUT shall provide:

(a) Automated checkout of the space vehicle in the VAB and on the launch pad in conjunction with equipment located in the LCC and the Operations and Checkout Building.

(b) Servicing for the space vehicle.

(c) Ingress to and egress from the CM.

(d) Personnel access to the space vehicle.

(e) Rapid emergency egress from the vicinity of a malfunctioning space vehicle.

(f) Protection from lightning damage prior to launch.

When secured at the launch pad, the LUT shall be capable of supporting the space vehicle in the 99.9 percentile peak surface wind conditions given in 2.3.2.1 of M-DE 8020.008B. The LUT shall permit launching the space vehicle during 95 percentile peak surface wind conditions given in 2.3.2.3 of M-DE 8020.008B.

3.6.4.3 Crawler Transporter The Crawler Transporter shall have the capability for:

(a) Lifting, transporting and positioning the LUT and the space vehicle (unfueled and unpressurized) without exceeding the free-standing or flight load capability of the space vehicle.

(b) Lifting, transporting and positioning the Arming Tower.

(c) Providing electric power and grounding for the LUT and Arming Tower during transport.

The Crawler Transporter shall be capable of transporting the LUT and space vehicle or the Arming Tower during the 99 percentile peak surface wind conditions given in 2.3.2.3 of M-DE 8020.008B.

The Crawler Transporter shall be capable of supporting the LUT and the space vehicle in the 99.9 percentile peak surface wind conditions given in 2.3.2.1 of M-DE 8020.008B while stopped between the VAB and the launch pad.

3.6.4.4 Launch Pads The launch pads shall provide for supporting final preparation and launch of the space vehicle including propellant loading, final checkout and countdown. The capability shall be provided for both day and night launches.

The launch pads shall be designed and located so as to permit concurrent preparation of space vehicles on adjacent pads.

3.6.4.5 Arming Tower The Arming Tower shall provide 360° access to the space vehicle for:

(a) Loading of spacecraft propellants, high-pressure gases and fuel cell cryogenics.

(b) Final ordnance installation and servicing of subsystems not accessible from the LUT.

The Arming Tower shall be capable of transport by the Crawler Transporter in the 99 percentile peak surface wind conditions as given in 2.3.2.3 of M-DE 8020.008B. While secured to the launch pad, the capability shall be provided for withstanding the 99.9 percentile peak surface wind conditions as given in 2.3.2.1 of M-DE 8020.008B without imposing a load on the space vehicle. The Arming Tower shall provide lightning protection for the space vehicle whenever the Arming Tower is in place at the Launch Pad and lightning protection for Arming Tower support systems at all times.

3.6.4.6 Launch Control Center The LCC shall provide the capability for:

(a) Centralized control and monitoring of space vehicle test operations, countdown, launch and early flight phases.

(b) Continuous evaluation of the status of the launch complex and the space vehicle.

(c) Display of spacecraft status data received from the Operations and Checkout Building.

(d) Supplying status information to HOSC and the MCC.

(e) Transmitting EDS data, checkpoint status data, countdown timing and checkout priority information to the Operations and Checkout Building.

(f) Supporting in-flight checkout of S-IVB/IU in Earth orbit.

(g) Conducting concurrent countdowns for two space vehicles.

3.6.5 Direct Launch Support Facilities

3.6.5.1 Operations and Checkout Building The Operations and Checkout Building shall:

(a) In conjunction with associated facilities, have the capability for conducting the test, preparation, assembly and checkout of the spacecraft modules and the spacecraft prior to mating with the launch vehicle.

(b) Provide a central point for conducting and monitoring spacecraft preparation activities.

(c) Perform automated checkout of the spacecraft during operations at LC 34, 37B and 39.

(d) Process and transmit spacecraft status data, including checkpoint status data and spacecraft checkout priority information, to the appropriate LCC for real time display.

(e) In conjunction with the CIF and the launch area MSFN site, have the capability for monitoring spacecraft and astronaut performance during launch.

(f) Provide spacecraft status information to the MCC.

3.6.5.2 Central Instrumentation Facility The CIF shall provide the capability for:

(a) Recording and processing data received via hardwire and rf links from the space vehicle and ground systems of the launch complexes, ETR and the launch area MSFN station.

(b) Transmitting real time and processed data for display to the LCC, MCC, Operations and Checkout Building, HOSC and Goddard Space Flight Center (GSFC).

(c) Receiving timing signals from the ETR and distributing the signals to the launch area as required and to the MCC and HOSC until launch.

(d) Conducting and monitoring launch area rf interference tests.

(e) Processing and providing tracking data to the ETR for range safety purposes.

3.6.5.3 Central Telephone Office The Central Telephone Office shall:

(a) Provide a flexible means for switching and transmitting all operational data among the launch complexes, the Operations and Checkout Building, the CIF, the ETR (Cape Kennedy) and the launch area MSFN site.

(b) Provide the interface for all operational communications between the launch area, and the MCC, HOSC, GSFC and ETR.

3.7 Manned Space Flight Network

3.7.1 General The MSFN shall have the capability for:

(a) Providing communications between the MCC and the space vehicle.

(b) Providing tracking data to determine the position and velocity of the space vehicle.

(c) Backup flight control at those stations where communications do not permit reliable flight control from the MCC.

(d) Recording pertinent voice and data communications during a mission.

(e) Synchronizing time between MSFN stations and between MSFN stations and the space vehicle.

(f) Conducting training exercises.

The communication and tracking network for Apollo shall make full use of the communication and tracking services, including range safety, to be supplied by the National Range Division of the Department of Defense.

3.7.2 Functional Capability

3.7.2.1 Voice Communications The voice communications subsystem shall enable:

(a) Duplex voice communications between the CSM and MCC or between the CSM and MSFN station as per 3.7.1 (c).

(b) Duplex voice communications between the LEM and MCC or between the LEM and MSFN station as per 3.7.1 (c).

(c) Conferencing between the LEM, CSM and MCC or between the LEM, CSM and MSFN station as per 3.7.1 (c).

(d) Two-way voice communications between the CSM and LEM using the MSFN as a relay.

(e) Reception of recorded voice from the CSM without interrupting normal voice communications.

(f) Reception of manually-keyed transmission from the CSM and LEM.

(g) Two-way voice communications between MCC and an EVA relayed by the CSM or LEM.

(h) Duplex, 4-wire voice communications between MSFN stations and MCC.

3.7.2.2 Telemetry The telemetry subsystem shall be able to receive:

(a) High or low bit rate operational data from the CSM.

(b) Recorded telemetry from the CSM at the high bit rate simultaneously with (a).

(c) High or low bit rate operational telemetry from the LEM simultaneously with (a) and (b).

(d) Operational telemetry from each stage of the launch vehicle and the IU simultaneously with (a) and (b).

(e) Engineering data from the space vehicle.

(f) Instrumentation and biomedical data from an EVA relayed by the CSM or the LEM.

(g) Scientific data from the CSM and LEM.

3.7.2.3 Tracking The tracking subsystem shall be able to:

(a) Track in angle, range and range rate the transponders in the CSM and LEM to lunar distances.

(b) Track the transponders in the launch vehicle in angle, range and range rate during the launch phase.

(c) Track in angle and range the IU transponders in Earth orbit.

(d) "Skin" track the space vehicle in Earth orbit.

(e) "Skin" track the CM during entry.

(f) Provide sampled tracking data for transmission to the MCC and, where required, for on-site computation.

3.7.2.4 Digital Command Communications The Digital Command Communications Subsystem (DCCS) shall be able to:

(a) Transmit up-data sequentially to the CSM and the IU.

(b) Monitor and verify the transmission of up-data to the space vehicle.

(c) Receive from the telemetry subsystem verification of accurate receipt of up-data at the CSM and the IU.

(d) Transmit verification signals received from the CSM and the IU to MCC.

(e) Be controlled by the display and control subsystem at the site or remotely from the MCC.

3.7.2.5 Television The television subsystem shall be able to:

(a) Receive and record television transmission from the CSM and the LEM.

(b) Transmit television received from the spacecraft to MCC from the MSFN station at Goldstone.

3.7.2.6 Display and Control The display and control subsystem shall be able to:

(a) Display selected mission information to flight control personnel.

(b) Control up-data transmission.

(c) Have access to all LEM, CSM and S-IVB/IU tracking and operational telemetry data at the site.

(d) Control voice communications between the CSM, LEM and the MCC or on-site flight control personnel.

3.7.2.7 Data Processing The data processing subsystem shall be able to:

(a) Process and format space vehicle tracking and operational telemetry information for use in the display and control subsystem or for transmission to MCC.

(b) Identify to the display and control subsystem and to the MCC, designated parameters that have exceeded specified limits.

(c) Provide backup for the DCCS.

3.7.2.8 Timing A timing subsystem shall be provided at MSFN sites to act as a source for timing signals necessary to condition and process tracking and telemetry data. The timing subsystem at these sites shall be capable of being synchronized with the United States National Standard of Frequency and Time-Interval (WWV). Synchronization with the National Standard shall be capable of being maintained to within 0.1 millisecond at each station. The basic clock frequency difference between stations shall be maintained to less than 2 parts in 10^{10}, plus a random component of 5 parts in 10^{11}.

3.7.3 Coverage Capability The MSFN station in the launch area shall be able to support the prelaunch checkout of the space vehicle on the launch pad.

The MSFN shall provide the coverage capabilities for:

(a) CSM as specified in Table 3.7-1.

(b) LEM as specified in Table 3.7-2.

(c) Saturn V launch vehicle as specified in Table 3.7-3.

(d) Saturn IB launch vehicle as specified in Table 3.7-4.

3.7.4 Performance The MSFN shall operate with the space vehicle subsystems as specified in 3.3.5, 3.4.5, 3.5.2.3 and 3.5.3.3.

During the launch phase, the MSFN in conjunction with ETR and launch area instrumentation shall provide the tracking data needed to satisfy requirements for flight control, range safety and engineering data.

The part of the MSFN using equipment operating in C-band shall provide angular and range data to the maximum design range of that equipment. The errors in the data due to noise shall not exceed 1.0 milliradian for angular measurements or 60 ft. for range measurements (one standard deviation values - the errors due to noise are, by definition, Gaussian distributed with zero mean). Bias errors in these measurements shall not exceed twice the value of the errors due to noise.

The MSFN, using Unified S-band equipment, shall provide range, range rate and angular measurements to lunar distances. Errors (one standard deviation values) due to noise shall not exceed 0.8 milliradian for angular measurements, 60 ft. for range and 0.1 fps for range rate measurements. Bias errors in these measurements shall not exceed twice the value of errors due to noise. Ranging and data acquisition times for Unified S-band equipment shall not exceed one minute from the time line-of-sight is established between the space vehicle and the MSFN station.

3.8 Mission Control Center

3.8.1 General The MCC shall provide the capability for directing and coordinating the overall mission from the decision to start mission operations until all phases of the mission are completed. It shall provide the capability for detailed monitoring, evaluation and control of the flight during all phases from liftoff until touchdown. The MCC shall also provide the capability for conducting simulated missions.

The MCC shall have the capability of supporting:

(a) One real and one simulated mission simultaneously.

(b) The mission schedule outlined in Apollo Flight Mission Assignments, M-D MA 500-11.

The MCC shall have the capability of providing a central control point for:

(c) The direction of mission operations and resources allocation.

(d) The evaluation of crew status.

(e) The collection and evaluation of weather and space environment information.

(f) The release of public information.

The MCC shall provide the capability for performing the functions of monitoring, evaluating and controlling the following:

(g) Flight operations and procedures.

(h) Space vehicle trajectory.

(i) In-flight performance of space vehicle systems including consumables remaining.

(j) Status and performance of the MSFN.

The major systems of the MCC are: Communications, Display and Control, Simulation Checkout and Training and Real Time Computer Complex.

3.8.2 Communication System The system shall provide for the MCC the capability for:

(a) Termination of all circiuits carrying teletype, voice, television and high speed and wideband data to and from NASA facilities providing direct support of the mission.

(b) Termination of other govenment circuits carrying voice, facsimile and teletype for recovery, weather and administrative purposes.

(c) Termination of commercial circuits carrying television and voice transmission for public information.

(d) Switching, storage and formatting of data and messages.

(e) Secure command transmission.

(f) Furnishing internal voice, hard-copy and public address communications.

3.8.3 Display and Control System The system shall provide the capability for:

(a) Selecting and displaying on individual monitors and large displays for group coordination raw, processed and reference data in standard formats.

(b) Initiating commands.

(c) Generating primary time bases for the mission and events within the mission.

3.8.4 Simulation, Checkout and Training System The system shall provide the capability for:

(a) Simulation of the operational environment external to the MCC.

(b) Coordination and control of the Mission Simulators at both Kennedy Space Center and Manned Spacecraft Center and the part of the Real Time Computer Complex assigned to the simulation.

(c) Checkout of MSFN, Apollo Launch Data System (ALDS) and MCC.

3.8.5 Real Time Computer Complex The Real Time Computer Complex shall provide the capability for:

(a) Generation of data for command and updating onboard information.

(b) Generation of acquisition data for MSFN.

(c) Smoothing and predicting of trajectory and system performance data.

(d) Computation of decision parameters.

(e) Simulation computations.

(f) Automatic warning of out-of-tolerance conditions.

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4.0 Quality Assurance

4.1 General Program performance, design and reliability requirements for accomplishment of manned lunar landing missions shall be achieved, maintained and verified by rigorous application of an integrated quality assurance and test program. The control and verification by test and inspection of identifiable performance parameters which affect the quality of Program equipment is mandatory for achievement of mission requirements. Adherence to design requirements and standards, and historical recording of the known condition of all Program equipment is required to assure that maximum developmental and corrective knowledge and data will be obtained from the test hardware provided.

4.2 Quality Assurance The integrity of program and project level performance, design and reliability requirements shall be maintained through the application of controls and disciplines specified in Section 10 of the Program Development Plan and in the Apollo Reliability and Quality Assurance Program Plan.

4.3 Program Performance Testing Program performance testing as prescribed by NPC 500-10 is required to assure accomplishment of the manned lunar landing missions. Specific application of this document for testing of Program equipment is as follows:

Category of Hardware	NPC 500-10 Requirements
Systems Compatibility	Section 3.5.3
All-Systems Test	Section 3.5.5
Ground Qualification Tests	Section 3.6
Ground Equipment Checkout Tests	Section 3.9
Space Vehicle Checkout	Section 3.10
Flight Verification Tests	Section 4.5

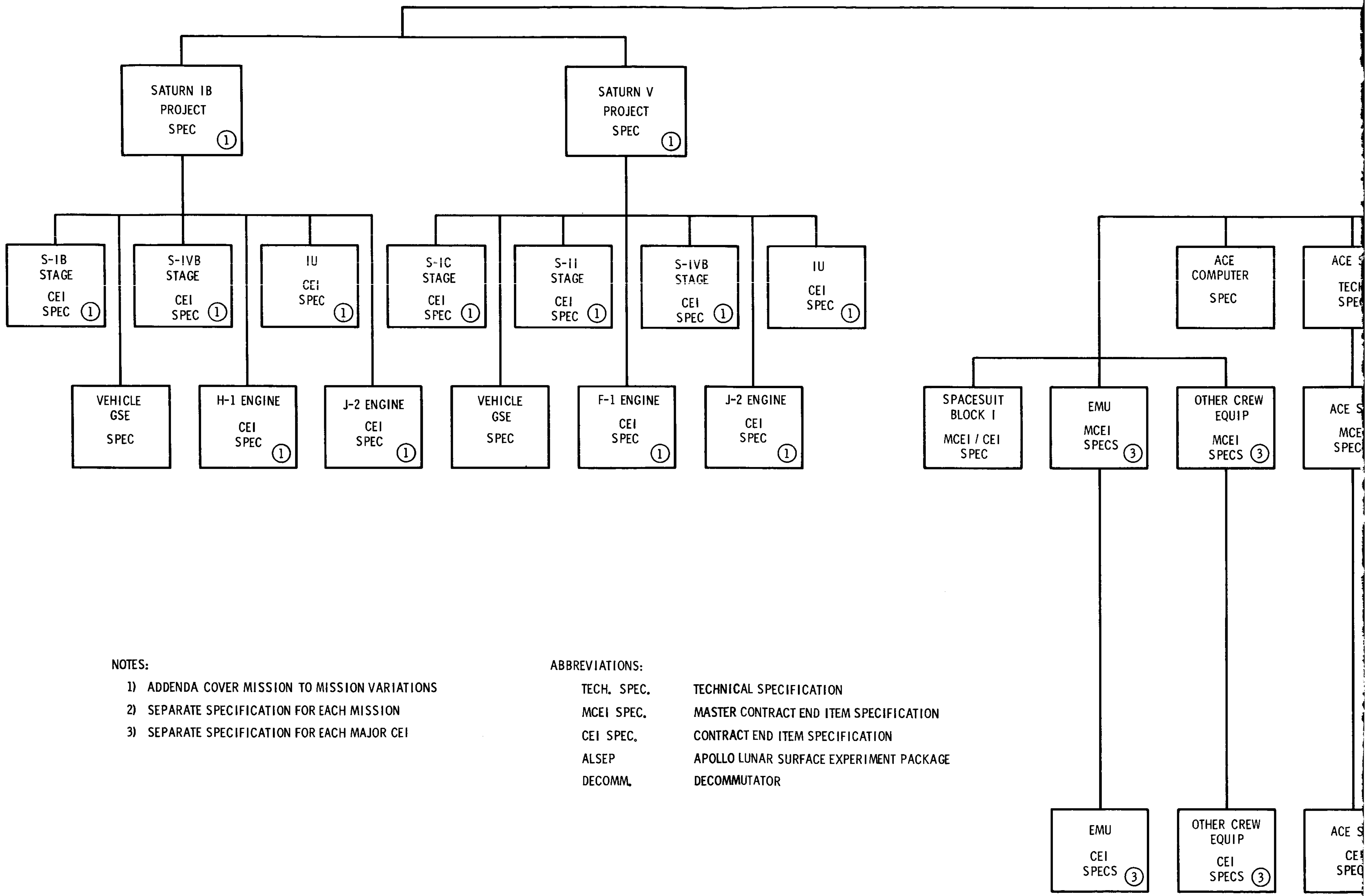
6.0 Acronyms and Abbreviations

ACE	Acceptance Checkout Equipment
AGC	Apollo Guidance Computer
ALDS	Apollo Launch Data System
ALSEP	Apollo Lunar Surface Experiments Package
AM	Amplitude Modulation
amp-hr	ampere-hour
APO	Apollo Program Office
APS	Apollo Program Specification
AS	Apollo Saturn
BLK	Block
BTU	British Thermal Unit
CCS	Command and Communication System
CEI	Contract End Item
CEP	Circular Error Probable
cg	center of gravity
CIF	Central Instrumentation Facility
cm	centimeter
CM	Command Module
cps	cycles per second
CSM	Command/Service Module
CW	Continuous Wave
db	decibels
DCCS	Digital Command Communications Subsystem
D&C	Displays and Controls
DECOM	Decommutator
DF	Direction Finder
DoD	Department of Defense
DPS	Descent Propulsion System
DSB	Double Sideband

DSBAM	Double Sideband Amplitude Modulation
ECS	Environmental Control Subsystem
EDS	Emergency Detection Subsystem
ELS	Earth Landing System
EMU	Extravehicular Mobility Unit
EPS	Electrical Power Subsystem
ETR	Eastern Test Range
EVA	Extravehicular Astronaut
F	Thrust
^{o}F	Degrees Fahrenheit
FM	Frequency Modulation
fps	feet per second
ft	feet
g	gravitational acceleration
GSE	Ground Support Equipment
GSFC	Goddard Space Flight Center
HF	High Frequency
Hg	mercury
HOSC	Huntsville Operations Support Center
IMU	Inertial Measurement Unit
Isp	specific impulse
IU	Instrument Unit
kc	kilocycles per second
KSC	Kennedy Space Center
kwh	kilowatt hours
lb	pound
LC	Launch Complex
LCC	Launch Control Center
LEM	Lunar Excursion Module
LES	Launch Escape System

LH_2	liquid hydrogen
LOR	Lunar Orbit Rendezvous
LUT	Launcher-Umbilical Tower
mc	megacylces per second
MCC	Mission Control Center
MCP	Mission Control Programmer
mcw	modulated continuous wave
MILA	Merritt Island Launch Area
Mistram	Missile Trajectory Measurement
mm	millimeter
MMH	Monomethylhydrazine
mr	milliradian
MSF	Manned Space Flight
MSFN	Manned Space Flight Network
N	North
N&G	Navigation and Guidance
nm	nautical mile
NRZ-C	Non-Return to Zero - Type C
ODOP	Offset Frequency Doppler
OMSF	Office of Manned Space Flight
PAM	Pulse Amplitude Modulation
PCM	Pulse Code Modulation
PDP	Program Development Plan
PIP	Pulse Integrating Pendulum
PM	Phase Modulation
PNGCS	Primary Navigation, Guidance and Control System
psi	pounds per square inch
psia	pounds per square inch absolute
PSK	Phase Shift Keying

RCS	Reaction Control Subsystem
R&D	Research and Development
rf	Radio Frequency
RFI	Radio Frequency Interference
RQ	Respiration Quotient - ratio of CO_2 produced to O_2 consumed by volume
S	South
SC	Spacecraft
SCATS	Simulation, Checkout, and Training Subsystem
SCI EQUIP	Scientific Equipment
SCS	Stabilization and Control System
sec	second
SM	Service Module
SPS	Service Propulsion Subsystem
SSBAM	Single Sideband Amplitude Modulation
SS/FM	Single Sideband Amplitude Modulation Frequency Modulated on carrier (SSBAM/FM)
TV	Television
UDMH	Unsymmetrical Dimethylhydrazine
UHF	Ultra High Frequency
USB	Unified S-Band
ΔV	Incremental Velocity
VAB	Vertical Assembly Building
VHF	Very High Frequency



NOTES:

1) ADDENDA COVER MISSION TO MISSION VARIATIONS
2) SEPARATE SPECIFICATION FOR EACH MISSION
3) SEPARATE SPECIFICATION FOR EACH MAJOR CEI

ABBREVIATIONS:

TECH. SPEC.	TECHNICAL SPECIFICATION
MCEI SPEC.	MASTER CONTRACT END ITEM SPECIFICATION
CEI SPEC.	CONTRACT END ITEM SPECIFICATION
ALSEP	APOLLO LUNAR SURFACE EXPERIMENT PACKAGE
DECOMM.	DECOMMUTATOR

#1

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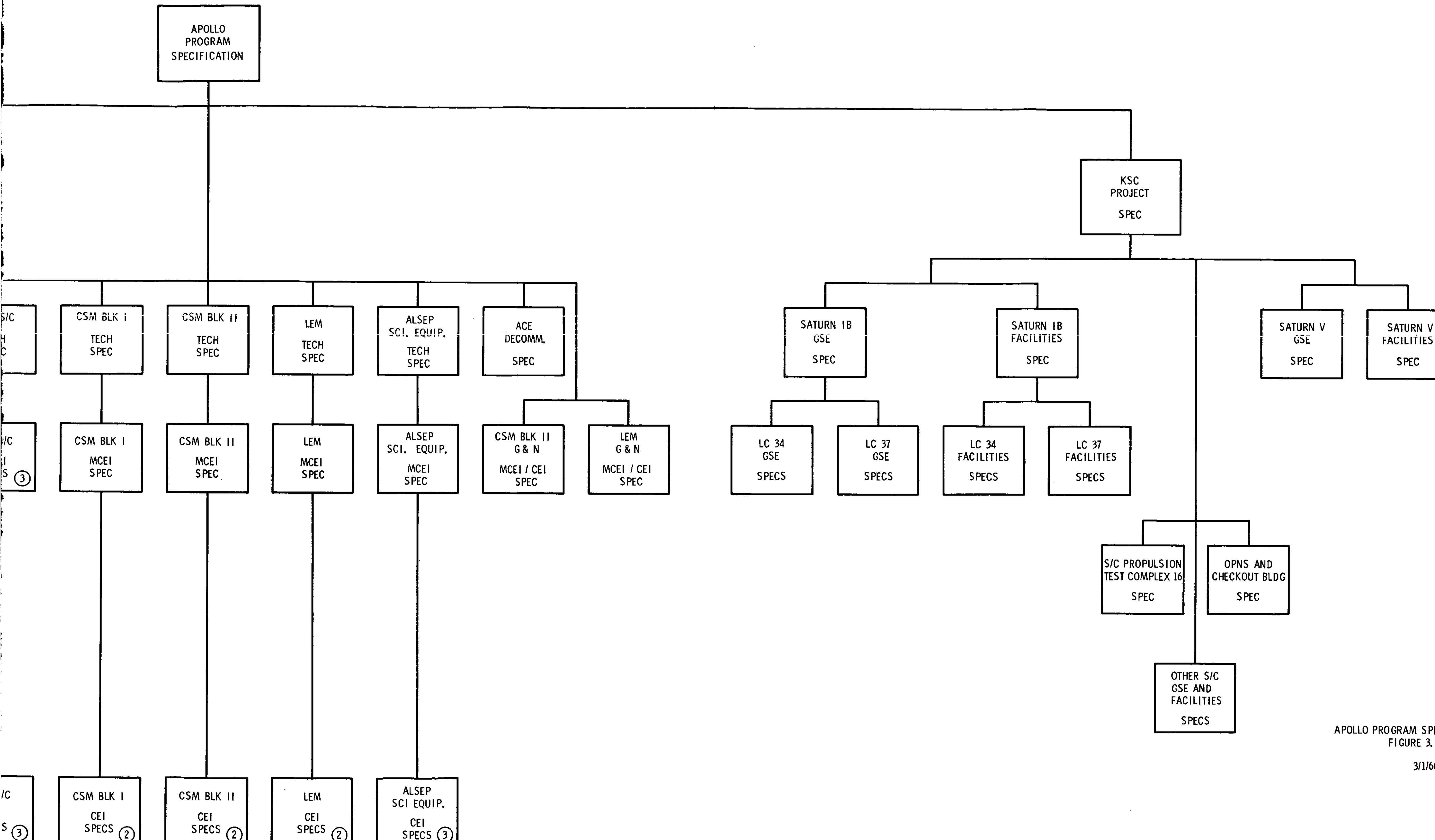

#2

APOLLO PROGRAM SPECIFICATION TREE
FIGURE 3.1 - 1

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TABLE 3.3-1

OPERATIONAL SATURN IB LAUNCH VEHICLE COMMUNICATION AND TRACKING REQUIREMENTS

STAGE / SUBSYSTEM	EQUIPMENT IMPLEMENTATION	NUMBER OF UNITS	OPERATING FREQUENCY		ANTENNA SUBSYSTEM	MODULATION CHARACTERISTICS	REMARKS
			TRANSMIT	RECEIVE			
S-IB TELEMETRY	PCM/FM TELEMETER	ONE	225-260 Mc		OMNI-DIRECTIONAL	PCM/FM	• SEE NOTES 1, 2 AND 3 • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND
	FM/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF S-IB PCM/FM TELEMETER	FM/FM	• SEE NOTES 1 AND 4 • PAM/FM/FM MODULATION UTILIZED DURING R & D FLIGHT PROGRAM
	PAM/FM/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF S-IB PCM/FM TELEMETER	PAM/FM/FM	• SEE NOTES 1 AND 4
	SS/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF S-IB PCM/FM TELEMETER	SS/FM	• SEE NOTE 4
COMMAND DESTRUCT	RECEIVER AND DECODER	TWO		400-450 Mc	OMNI-DIRECTIONAL		• THIS SYSTEM SHALL BE COMPATIBLE WITH RANGE SAFETY COMMAND TRANSMITTERS INSTALLED AT STATIONS OF THE ETR.
TRACKING	ODOP TRANSPONDER	ONE	UHF	UHF	FIXED DIRECTIONAL		
S-IVB TELEMETRY	PCM/FM TELEMETER	ONE	225-260 Mc		OMNI-DIRECTIONAL	PCM/FM	• SEE NOTES 1, 2 AND 3 • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND
	FM/FM TELEMETER 6	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF S-IVB PCM/FM TELEMETER	FM/FM	• SEE NOTES 1 AND 4 • PAM/FM/FM MODULATION UTILIZED DURING R & D FLIGHT PROGRAM
	PAM/FM/FM TELEMETER	TWO	225-260 Mc		SEE NOTE 5	PAM/FM/FM	• SEE NOTES 1 AND 4
	SS/FM TELEMETER	ONE	225-260 Mc		SEE NOTE 5	SS/FM	• SEE NOTE 4
COMMAND DESTRUCT	RECEIVER AND DECODER	TWO		400-450 Mc	OMNI-DIRECTIONAL		• THIS SYSTEM SHALL BE COMPATIBLE WITH RANGE SAFETY COMMAND TRANSMITTERS INSTALLED AT STATIONS OF THE ETR.
INSTRUMENT UNIT TELEMETRY	PCM/FM TELEMETER	ONE	225-260 Mc		OMNI-DIRECTIONAL	PCM/FM	• SEE NOTES 1, 2 AND 3 • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND • BIT STREAM SHALL CONTAIN ALL S-IVB/IU MISSION CONTROL DATA
	PCM/FM TELEMETER	ONE	2100-2300 Mc			PCM/FM	• SEE NOTES 1, 2 AND 3 • EXPERIMENTAL SYSTEM • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND • BIT STREAM SHALL BE IDENTICAL WITH IU VHF PCM/FM TELEMETER
	FM/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF IU VHF PCM/FM TELEMETER	FM/FM	• SEE NOTES 1 AND 4
	PAM/FM/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF IU VHF PCM/FM TELEMETER	PAM/FM/FM	• SEE NOTES 1 AND 4
	SS/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF IU VHF PCM/FM TELEMETER	SS/FM	• SEE NOTE 4
UP-DATA	RECEIVER & DECODER	ONE		400-450 Mc	OMNI-DIRECTIONAL	PSK/FM	• SUBCODED 5-BIT WORDS AT 1000 BITS/SECOND • SEE NOTE 7
COMMAND DESTRUCT (EXPERIMENTAL)	RECEIVER AND DECODER	ONE		400-450 Mc	OMNI-DIRECTIONAL		• THIS SYSTEM SHALL BE COMPATIBLE WITH RANGE SAFETY COMMAND TRANSMITTERS INSTALLED AT STATIONS OF THE ETR. • PASSENGER TEST SA-201 ONLY
TRACKING	C-BAND RADAR TRANSPONDER	ONE	C-BAND	C-BAND	OMNI-DIRECTIONAL	PULSE	• UTILIZES CODING DIFFERENT FROM C-BAND RADAR TRANSPONDERS ON SPACECRAFT
	AZUSA TRANSPONDER	ONE	C-BAND	C-BAND	OMNI-DIRECTIONAL	FM	
TELEVISION	TELEVISION TRANSMITTER	ONE					

NOTES:

1. THIS TELEMETRY SUBSYSTEM SHALL BE COMPATIBLE WITH THE INTER RANGE INSTRUMENTATION GROUP STANDARDS (IRIG DOCUMENT NO. 106-60. "TELEMETRY STANDARDS REVISED 1962")

2. ALL PCM TELEMETRY SUBSYSTEMS SHALL BE DESIGNED TO PROVIDE AN ERROR RATE NOT EXCEEDING ONE BIT IN 10^6 BITS FOR TRANSMISSIONS TO THE MSFN AS MEASURED FROM LAUNCH VEHICLE ENCODER TO EARTH-BASED DECODER.

3. THIS PCM TELEMETRY SUBSYSTEM SHALL BE CAPABLE OF TRANSMITTING THE PCM BIT STREAM REQUIRED FOR REAL-TIME USE VIA COAXIAL CABLE TO THE CHECKOUT FACILITY PRIOR TO LIFT-OFF AND VIA AN RF LINK PRIOR TO AND AFTER LIFT-OFF.

4. THIS TELEMETRY SUBSYSTEM SHALL TRANSMIT DATA REQUIRED ONLY FOR POST-MISSION ANALYSIS VIA AN RF LINK.

5. UP TO 4 VHF STAGE TELEMETERS SHALL BE MULTIPLEXED ON A COMMON ANTENNA SUB-SYSTEM. WHEN MORE THAN 4 VHF STAGE TELEMETERS ARE CARRIED, A SECOND OMNI-DIRECTIONAL ANTENNA SUBSYSTEM SHALL BE PROVIDED.

6. NOT PRESENTLY SCHEDULED FOR OPERATIONAL SATURN IB LAUNCH VEHICLES. HOWEVER, PROVISIONS TO CARRY THIS TELEMETER SHALL BE INCORPORATED ON ALL SATURN IB LAUNCH VEHICLES THROUGH AS-207.

7. THE UP-DATA SUBSYSTEM SHALL BE DESIGNED IN CONJUNCTION WITH STATIONS OF THE MSFN SUCH THAT NO MORE THAN ONE CORRECT MESSAGE SHALL BE REJECTED PER 1000 CORRECT MESSAGES AND THAT NO MORE THAN ONE PER 10^9 INCORRECT MESSAGES SHALL BE ACCEPTED.

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EQUIPMENT/FUNCTION: THIS FLIGHT	EQUIPMENT/FUNCTION: OPERATIONAL VEHICLE	CODING
REQUIRED	REQUIRED	
REQUIRED	NOT REQUIRED	
NOT REQUIRED	REQUIRED	
NOT REQUIRED	NOT REQUIRED	

TABLE 3.3-1

TABLE 3. 4-1

OPERATIONAL SATURN V LAUNCH VEHICLE COMMUNICATIONS AND TRACKING REQUIREMENTS

STAGE / SUBSYSTEM	EQUIPMENT IMPLEMENTATION	NUMBER OF UNITS	OPERATING FREQUENCY TRANSMIT	OPERATING FREQUENCY RECEIVE	ANTENNA SUBSYSTEM	MODULATION CHARACTERISTICS	REMARKS
S - IC TELEMETRY	PCM/FM TELEMETER	ONE	225-260 Mc		OMNI-DIRECTIONAL	PCM/FM	• SEE NOTES 1, 2 AND 3 • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND
	FM/FM TELEMETER	ONE	225-260 Mc		SEE NOTE 5	FM/FM	• SEE NOTES 1 AND 4 • PAM/FM/FM MODULATION UTILIZED DURING R & D FLIGHT PROGRAM
	PAM/FM/FM TELEMETER	TWO	225-260 Mc		SEE NOTE 5	PAM/FM/FM	• SEE NOTES 1 AND 4
	SS/FM TELEMETER	TWO	225-260 Mc		SEE NOTE 5	SS/FM	• SEE NOTE 4
COMMAND DESTRUCT	RECEIVER AND DECODER	TWO		400-450 Mc	OMNI-DIRECTIONAL		• THIS SYSTEM SHALL BE COMPATIBLE WITH RANGE SAFETY COMMAND TRANSMITTERS INSTALLED AT STATIONS OF THE ETR
TRACKING	ODOP TRANSPONDER [6]	ONE	UHF	UHF	FIXED DIRECTIONAL		
TELEVISION	TELEVISION TRANSMITTER	ONE	1700-1730 Mc				
S - II TELEMETRY	PCM/FM TELEMETER	ONE	225-260 Mc		OMNI-DIRECTIONAL	PCM/FM	• SEE NOTES 1, 2 AND 3 • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND
	FM/FM TELEMETER	TWO	225-260 Mc		SEE NOTE 5	FM/FM	• SEE NOTES 1 AND 4 • PAM/FM/FM MODULATION UTILIZED DURING R & D FLIGHT PROGRAM
	PAM/FM/FM TELEMETER	ONE	225-260 Mc		SEE NOTE 5	PAM/FM/FM	• SEE NOTES 1 AND 4
	SS/FM TELEMETER	TWO	225-260 Mc		SEE NOTE 5	SS/FM	• SEE NOTE 4
COMMAND DESTRUCT	RECEIVER AND DECODER	TWO		400-450 Mc	OMNI-DIRECTIONAL		• THIS SYSTEM SHALL BE COMPATIBLE WITH RANGE SAFETY COMMAND TRANSMITTERS INSTALLED AT STATIONS OF THE ETR
S - IVB TELEMETRY	PCM/FM TELEMETER	ONE	225-260 Mc		OMNI-DIRECTIONAL	PCM/FM	• SEE NOTES 1, 2 AND 3 • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND
	FM/FM TELEMETER [7]	ONE	225-260 Mc		SEE NOTE 5	FM/FM	• SEE NOTES 1 AND 4 • PAM/FM/FM MODULATION UTILIZED DURING R & D FLIGHT PROGRAM
	PAM/FM/FM TELEMETER	TWO	225-260 Mc		SEE NOTE 5	PAM/FM/FM	• SEE NOTES 1 AND 4
	SS/FM TELEMETER	ONE	225-260 Mc		SEE NOTE 5	SS/FM	• SEE NOTE 4
COMMAND DESTRUCT	RECEIVER AND DECODER	TWO		400-450 Mc	OMNI-DIRECTIONAL		• THIS SYSTEM SHALL BE COMPATIBLE WITH RANGE SAFETY COMMAND TRANSMITTERS INSTALLED AT STATIONS OF THE ETR
INSTRUMENT UNIT TELEMETRY	PCM/FM TELEMETER	ONE	225-260 Mc		OMNI-DIRECTIONAL	PCM/FM	• SEE NOTES 1, 2 AND 3 • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND • THE TELEMETRY SHALL CONTAIN ALL S-IVB/IU MISSION CONTROL DATA
	PCM/FM TELEMETER [6]	ONE	S-BAND		FIXED DIRECTIONAL VARIABLE BEAMWIDTH	PCM/FM	• SEE NOTES 1 AND 2 • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND • TRANSMITS THE SAME BIT STREAM AS THE IU VHF PCM/FM TELEMETER
	FM/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF IU VHF PCM/FM TELEMETER	FM/FM	• SEE NOTES 1 AND 4
	PAM/FM/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF IU VHF PCM/FM TELEMETER	PAM/FM/FM	• SEE NOTES 1 AND 4
	SS/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF IU VHF PCM/FM TELEMETER	SS/FM	• SEE NOTES 4
	COMMAND AND COMMUNICATION SYSTEM (CCS)	ONE	S-BAND		MULTIPLEXED WITH OUTPUT OF IU S-BAND PCM/FM TELEMETER	PCM/PM/PM	• THIS SYSTEM SHALL PROVIDE TELEMETRY TRANSMISSION, UP-DATA RECEPTION AND TRACKING ASSISTANCE TO THE MSFN • UTILIZES SAME OPERATING FREQUENCIES AS THE LEM USB SYSTEM • SEE NOTE 2 • THE CCS TRANSMITS THE SAME BIT STREAM AS THE S-IVB VHF PCM/FM TELEMETER AT A BIT RATE OF 72 KILOBITS/SECOND
UP - DATA	CCS			S-BAND		PSK/FM/PM SUBCODED 5-BIT WORDS AT 1000 BITS/SECOND	• NO MORE THAN ONE CORRECT MESSAGE SHALL BE REJECTED PER 1000 CORRECT MESSAGES AND NO MORE THAN ONE PER 10^9 INCORRECT MESSAGES SHALL BE ACCEPTED
TRACKING AID	CCS		S-BAND	S-BAND		PM	• TRANSMITTED FREQUENCY SHALL BE IN THE RATIO OF 240:221 TO THE RECEIVED FREQUENCY • COHERENT TURN-AROUND CARRIER • COHERENT TURN-AROUND RANGE CODE
	C-BAND RADAR TRANSPONDER	ONE	C-BAND	C-BAND	OMNI-DIRECTIONAL	PULSE	• UTILIZES CODING DIFFERENT FROM C-BAND RADAR TRANSPONDERS ON SPACECRAFT
	AZUSA TRANSPONDER	ONE	C-BAND	C-BAND	OMNI-DIRECTIONAL	FM	

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NOTES:

1. THIS TELEMETRY SUBSYSTEM SHALL BE COMPATIBLE WITH THE INTER RANGE INSTRUMENTATION GROUP STANDARDS (IRIG DOCUMENT NO. 106-60 "TELEMETRY STANDARDS REVISED 1962").

2. ALL PCM TELEMETRY SUBSYSTEMS SHALL BE DESIGNED TO PROVIDE AN ERROR RATE NOT EXCEEDING ONE IN 10^6 BITS FOR TRANSMISSIONS TO THE MSFN AS MEASURED FROM LAUNCH VEHICLE ENCODER TO EARTH-BASED DECODER.

3. THIS PCM/FM TELEMETRY SUBSYSTEM SHALL TRANSMIT THE PCM BIT STREAM REQUIRED FOR REAL-TIME USE VIA COAXIAL CABLE TO THE CHECKOUT FACILITY IN THE MILA PRIOR TO LIFT-OFF AND VIA AN RF LINK PRIOR TO AND AFTER LIFT-OFF.

4. THIS TELEMETRY SUBSYSTEM SHALL TRANSMIT DATA REQUIRED ONLY FOR POST-MISSION ANALYSIS VIA AN RF LINK.

5. UP TO 4 VHF STAGE TELEMETERS SHALL BE MULTIPLEXED ON A COMMON ANTENNA SUB-SYSTEM. WHEN MORE THAN 4 VHF STAGE TELEMETERS ARE CARRIED, A SECOND OMNI-DIRECTIONAL ANTENNA SUBSYSTEM SHALL BE PROVIDED.

6. POSSIBILITY OF REQUIREMENTS BEING FULFILLED BY THE CCS.

7. NOT PRESENTLY SCHEDULED FOR OPERATIONAL SATURN V LAUNCH VEHICLES. HOWEVER, PROVISIONS TO CARRY THIS TELEMETER SHALL BE INCORPORATED ON ALL SATURN V LAUNCH VEHICLES THROUGH AS-506.

LEGEND

EQUIPMENT/FUNCTION THIS FLIGHT	EQUIPMENT/FUNCTION LUNAR MISSION	CODING
REQUIRED	REQUIRED	
REQUIRED	NOT REQUIRED	
NOT REQUIRED	REQUIRED	
NOT REQUIRED	NOT REQUIRED	

TABLE 3. 4-1

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TABLE 3.5-2A

CSM COMMUNICATIONS AND TRACKING REQUIREMENTS

SUBSYSTEM	EQUIPMENT IMPLEMENTATION	NUMBER OF UNITS	OPERATING FREQUENCY TRANSMIT	OPERATING FREQUENCY RECEIVE	ANTENNA SUBSYSTEM	MODULATION CHARACTERISTICS	REMARKS
VOICE COMMUNICATIONS WITH MSFN	UNIFIED S-BAND SYSTEM						● SEE TABLE 3.5-2B FOR REQUIREMENTS
(SEE NOTE 1) WITH MSFN	VHF TRANSCEIVER #1	ONE	VHF	VHF	OMNI-DIRECTIONAL	DSBAM TRANSMIT DSBAM RECEIVE	● ALTERNATE NEAR-EARTH VOICE COMMUNICATIONS CHANNEL VIA SIMPLEX MODE OF OPERATION ● PRIMARY VOICE COMMUNICATIONS CHANNEL WITH LEM VIA SIMPLEX MODE OF OPERATION ● PRIMARY TRANSMITTER FOR DUPLEX VOICE COMMUNICATIONS WITH EVA ● ALTERNATE BACK-UP FOR VOICE COMMUNICATIONS WITH EVA VIA SIMPLEX MODE OF OPERATION ● ALTERNATE VOICE COMMUNICATIONS CHANNEL WITH RECOVERY FORCES VIA SIMPLEX MODE OF OPERATION
WITH MSFN	VHF TRANSCEIVER #2				MULTIPLEXED WITH TRANSCEIVER #1	DSBAM TRANSMIT DSBAM RECEIVE	● UTILIZED FOR VOICE RECEPTION SIMULATION DURING R & D FLIGHT PROGRAM ● SEE "VOICE COMMUNICATIONS WITH LEM"
WITH LEM	VHF TRANSCEIVER #1						● SEE "VOICE COMMUNICATIONS WITH MSFN"
WITH LEM	VHF TRANSCEIVER #2	ONE	VHF	VHF	MULTIPLEXED WITH TRANSCEIVER #1	DSBAM TRANSMIT DSBAM RECEIVE	● BACK-UP VOICE COMMUNICATIONS CHANNEL WITH LEM VIA SIMPLEX MODE OF OPERATION ● RECEIVES LEM PCM/AM DATA ● PRIMARY RECEIVER FOR DUPLEX VOICE COMMUNICATIONS WITH EVA ● RECEIVES EVA BIOMEDICAL DATA SIMULTANEOUSLY WITH EVA VOICE ● ALTERNATE BACK-UP FOR VOICE COMMUNICATIONS WITH EVA VIA SIMPLEX MODE OF OPERATIONS
WITH EVA	VHF TRANSCEIVER #1						● SEE "VOICE COMMUNICATIONS WITH MSFN"
WITH EVA	VHF TRANSCEIVER #2						● SEE "VOICE COMMUNICATIONS WITH LEM"
WITH RECOVERY FORCES	HF TRANSCEIVER	ONE	HF	HF	OMNI-DIRECTIONAL	AM, CW, SSB	● ALSO PROVIDES BEACON MODE OF OPERATION FOR DF AFTER LANDING ● HF RECOVERY ANTENNA DEPLOYED AFTER LANDING
WITH RECOVERY FORCES	SURVIVAL TRANSCEIVER	ONE	VHF	VHF	UTILIZES EITHER VHF RECOVERY ANTENNA	AM	● PART OF CREW SURVIVAL EQUIPMENT ● BACK-UP FOR VHF VOICE COMMUNICATIONS WITH RECOVERY FORCES ● BACK-UP FOR VHF RECOVERY BEACON
WITH RECOVERY FORCES	VHF TRANSCEIVER #1				OMNI-DIRECTIONAL RECOVERY ANTENNA #2		● RECOVERY ANTENNA DEPLOYED AT MAIN CHUTE DEPLOYMENT ● SEE "VOICE COMMUNICATIONS WITH MSFN"
KEYING COMMUNICATIONS TO MSFN	UNIFIED S-BAND SYSTEM						● SEE TABLE 3.5-2B FOR REQUIREMENTS
TELEMETRY TO MSFN	UNIFIED S-BAND SYSTEM						● SEE TABLE 3.5-2B FOR REQUIREMENTS
TO MSFN	PCM/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH TRANSCEIVER #1	PCM/FM NRZ-C SERIAL BIT STREAM	● SEE NOTES 2, 3, AND 5 ● SELECTABLE BIT RATES OF 51.2 KBS AND 1.6 KBS ● ALSO PROVIDES PLAYBACK OF RECORDED CSM PCM TELEMETRY
TO MSFN	PAM/FM/FM TELEMETER	TWO	225-260 Mc		MULTIPLEXED WITH TRANSCEIVER #1	PAM/FM/FM	● TRANSMIT DATA REQUIRED ONLY FOR POST-FLIGHT ANALYSIS ● SEE NOTE 3
TO MSFN	FM TELEMETER	ONE	225-260 Mc			PCM/FM OR FM/FM	● TRANSMITS DATA REQUIRED ONLY FOR POST-FLIGHT ANALYSIS ● SEE NOTE 3
FROM LEM	VHF TRANSCEIVER #2					PCM/AM	● SEE "VOICE COMMUNICATIONS WITH LEM" ● SEE NOTE 4 ● PCM BIT RATE OF 1.6 KILOBITS/SECOND
FROM EVA	VHF TRANSCEIVER #2					FM/AM	● SEE "VOICE COMMUNICATIONS WITH LEM"
TAPE PLAYBACK TO MSFN	UNIFIED S-BAND SYSTEM						● SEE TABLE 3.5-2B FOR REQUIREMENTS
TO MSFN	PCM/FM TELEMETER						● SEE "TELEMETRY TO MSFN"
TELEVISION TO MSFN	UNIFIED S-BAND SYSTEM						● SEE TABLE 3.5-2B FOR REQUIREMENTS
UP-DATA (SEE NOTE 6) FROM MSFN	UNIFIED S-BAND SYSTEM						● SEE TABLE 3.5-2B FOR REQUIREMENTS
FROM MSFN	RECEIVER AND DECODER	ONE		400-450 Mc	UTILIZES TRANSCEIVER #1 IN-FLIGHT ANTENNA	PSK/FM	● SUBCODED 5-BIT WORDS AT 1000 BITS/SECOND
TRACKING AID TO MSFN	UNIFIED S-BAND SYSTEM						● SEE TABLE 3.5-2B FOR REQUIREMENTS
TO MSFN	C-BAND RADAR TRANSPONDER	ONE	C-BAND	C-BAND	OMNI-DIRECTIONAL	PULSE	● UTILIZES CODING DIFFERENT FROM LAUNCH VEHICLE AND LEM C-BAND RADAR TRANSPONDERS
TO LEM	RENDEZVOUS RADAR TRANSPONDER	ONE	X-BAND	X-BAND	OMNI-DIRECTIONAL	PM RECEIVE PM TRANSMIT	● THREE TONE RANGE CODE AND COHERENT CARRIER TURN-AROUND
BEACON TO RECOVERY FORCES	RECOVERY BEACON	ONE	VHF		OMNI-DIRECTIONAL RECOVERY ANTENNA #1	AM	● RECOVERY ANTENNA DEPLOYED AT MAIN CHUTE DEPLOYMENT
TO RECOVERY FORCES	HF TRANSCEIVER					CW	● SEE "VOICE COMMUNICATIONS WITH RECOVERY FORCES"
TO RECOVERY FORCES	SURVIVAL TRANSCEIVER					AM	● SEE "VOICE COMMUNICATIONS WITH MSFN"

3/1/66

NOTES:

1. THE MINIMUM WORD INTELLIGIBILITY SHALL BE 90% FOR NORMAL VOICE COMMUNICATIONS AND 70% FOR BACK-UP COMMUNICATIONS AS MEASURED BY USER PERSONNEL UNDER SIMULATED OPERATING CONDITIONS UTILIZING THE AMERICAN STANDARD METHOD FOR MEASUREMENT OF MONOSYLLABIC WORD INTELLIGIBILITY DATED MAY 25, 1960.
2. THE TELEMETRY SUBSYSTEM SHALL BE DESIGNED TO PROVIDE AN ERROR RATE NOT EXCEEDING ONE BIT IN 10^6 BITS FOR TRANSMISSIONS TO THE MSFN AS MEASURED FORM CSM ENCODER TO MSFN DECODER.
3. THIS TELEMETRY SUBSYSTEM SHALL BE COMPATIBLE WITH THE INTER RANGE INSTRUMENTATION GROUP STANDARDS (IRIG DOCUMENT NO. 106-60, "TELEMETRY STANDARDS REVISED 1962")
4. THE TELEMETRY SUBSYSTEM SHALL BE DESIGNED TO PROVIDE AN ERROR RATE NOT EXCEEDING ONE BIT IN 10^4 BITS FOR PCM TELEMETRY TRANSMISSION TO THE CSM AS MEASURED FROM LEM ENCODER TO THE CSM RECORDER.
5. THIS PCM TELEMETRY SUBSYSTEM SHALL BE CAPABLE OF TRANSMITTING THE PCM BIT STREAM REQUIRED FOR REAL-TIME USE VIA COAXIAL CABLE TO THE CHECKOUT FACILITY IN THE MILA PRIOR TO LIFT-OFF AND VIA AN RF LINK PRIOR TO AND AFTER LIFT-OFF.
6. NO MORE THAN ONE CORRECT MESSAGE SHALL BE REJECTED PER 1000 CORRECT MESSAGES AND NO MORE THAN ONE PER 10^9 INCORRECT MESSAGES SHALL BE ACCEPTED.

LEGEND

EQUIPMENT/FUNCTION THIS FLIGHT	EQUIPMENT/FUNCTION LUNAR MISSION	CODING
REQUIRED	REQUIRED	
REQUIRED	NOT REQUIRED	
NOT REQUIRED	REQUIRED	
NOT REQUIRED	NOT REQUIRED	

TABLE 3.5-2A

TABLE 3.5-2B

CSM UNIFIED S-BAND COMMUNICATIONS AND TRACKING REQUIREMENTS

SUBSYSTEM	EQUIPMENT IMPLEMENTATION	NUMBER OF UNITS	OPERATING FREQUENCY TRANSMIT	OPERATING FREQUENCY RECEIVE	ANTENNA SUBSYSTEM	MODULATION CHARACTERISTICS	REMARKS
VOICE COMMUNICATIONS (SEE NOTE 1) WITH MSFN	PM TRANSPONDER	TWO	S-BAND	S-BAND	OMNI-DIRECTIONAL DIRECTIONAL - VARIABLE BEAMWIDTH	FM/PM TRANSMIT - 1.25 Mc SUBCARRIER FM/PM RECEIVE 30 Kc SUBCARRIER	● TRANSPONDER FREQUENCY SHALL BE COHERENT WITH SIGNALS RECEIVED FROM THE MSFN AND IN THE RATIO OF 240:221 ● RELAY VOICE AND TELEMETRY COMMUNICATIONS WITH EVA ● BACKUP RELAY OF VOICE COMMUNICATIONS WITH LEM ● TRANSPONDER ALSO PROVIDES FOR TELEMETRY TRANSMISSION, KEYED TRANSMISSION, UP-DATA RECEPTION AND TRACKING ASSISTANCE TO THE MSFN,
						PM TRANSMIT AT BASEBAND	● EMERGENCY VOICE TRANSMISSION ● THIS CAPABILITY IS PROVIDED ONLY WHEN THE CAPABILITY FOR SIMULTANEOUS PM AND FM S-BAND TRANSMISSION IS PROVIDED.
						FM/PM RECEIVE 70 Kc SUBCARRIER	● EMERGENCY VOICE RECEPTION ● THIS CAPABILITY IS PROVIDED ONLY WHEN THE CAPABILITY FOR SIMULTANEOUS PM AND FM S-BAND TRANSMISSION IS PROVIDED. ● SEE "UP-DATA FROM MSFN"
WITH MSFN	FM TRANSMITTER #1	ONE	S-BAND		MULTIPLEXED WITH S-BAND TRANSPONDER OMNI-DIRECTIONAL ANTENNA SYSTEM	FM/FM TRANSMIT 1.25 Mc SUBCARRIER	● THIS TRANSMITTER OPERATES ON THE SAME FREQUENCY AS THE TRANSPONDER, THEREFORE IT IS PROVIDED ONLY ON THOSE FLIGHTS FOR WHICH SIMULTANEOUS PM AND FM S-BAND TRANSMISSION IS NOT REQUIRED. ● VOICE RECEPTION IS ACHIEVED VIA PM RECEPTION OF 30 Kc FM SUBCARRIER. ● TRANSMITTER ALSO PROVIDES FOR TELEMETRY, SCIENTIFIC DATA, TELEVISION, AND TAPE PLAYBACK TRANSMISSION TO THE MSFN.
KEYING COMMUNICATIONS TO MSFN	PM TRANSPONDER		S-BAND			AM/PM 512 Kc SUBCARRIER	● SEE "VOICE COMMUNICATIONS WITH MSFN" ● TRANSMITTED ALONE - BACKUP FOR VOICE TRANSMISSION
TELEMETRY TO MSFN	PM TRANSPONDER		S-BAND			PCM/PM/PM 1.024 Mc SUBCARRIER NRZ-C SERIAL BIT STREAM	● SEE "VOICE COMMUNICATIONS WITH MSFN" ● SELECTABLE BIT RATES OF 51.2 KILOBITS/SECOND AND 1.6 KILOBITS/SECOND ● SEE NOTES 2 AND 3
						FM/FM/PM 7 SUBCARRIERS ON 1.25 Mc VOICE SUBCARRIER	● SEE "VOICE COMMUNICATIONS WITH MSFN" ● RELAY OF COMPOSITE EVA VOICE AND 7 CHANNELS OF EVA TELEMETRY ON VOICE SUBCARRIER WHEN SIMULTANEOUS PM AND FM S-BAND TRANSMISSION CAPABILITY IS PROVIDED.
TO MSFN	FM TRANSMITTER #1		S-BAND			PCM/PM/FM 1.024 Mc SUBCARRIER NRZ-C SERIAL BIT STREAM	● SEE "VOICE COMMUNICATIONS WITH MSFN" ● SELECTABLE BIT RATES OF 51.2 KILOBITS/SECOND AND 1.6 KILOBITS/SECOND ● SEE NOTES 2 AND 3
						FM/FM 95 Kc, 125 Kc, 165 Kc SUBCARRIERS	● SEE "VOICE COMMUNICATIONS WITH MSFN" ● PROVIDES 3 CHANNELS OF REAL TIME SCIENTIFIC DATA TRANSMISSION TO THE MSFN ● SIX ADDITIONAL SUBCARRIERS ARE ALSO AVAILABLE
TO MSFN	FM TRANSMITTER #2	ONE	S-BAND		MULTIPLEXED WITH S-BAND TRANSPONDER ANTENNA SYSTEM	FM/FM 95 Kc, 125 Kc, 165 Kc SUBCARRIERS	● THIS TRANSMITTER IS PROVIDED ONLY ON THOSE FLIGHTS FOR WHICH SIMULTANEOUS PM AND FM S-BAND TRANSMISSION IS REQUIRED. ● TRANSMITTER ALSO PROVIDES FOR TELEVISION AND TAPE PLAYBACK TRANSMISSION TO THE MSFN. ● PROVIDES 3 CHANNELS OF REAL TIME SCIENTIFIC DATA TRANSMISSION TO THE MSFN
TAPE PLAYBACK TO MSFN	FM TRANSMITTER #1		S-BAND				● SEE "VOICE COMMUNICATIONS WITH MSFN"
						FM/FM 95 Kc, 125 Kc, 165 Kc SUBCARRIERS	● RECORDED SCIENTIFIC DATA - 3 CHANNELS ● SIX ADDITIONAL CHANNELS ARE ALSO AVAILABLE
						FM/FM ANALOG SUBCARRIER	● RECORDED VOICE
						PCM/PM/FM 1.024 Mc SUBCARRIER	● RECORDED CSM PCM TELEMETRY AT APPARENT 51.2 KILOBITS/SECOND RATE
TO MSFN	FM TRANSMITTER #2		S-BAND				● SEE "TELEMETRY TO MSFN"
						FM/FM 95 Kc, 125 Kc, 165 Kc SUBCARRIERS	● RECORDED SCIENTIFIC DATA - 3 CHANNELS
						FM AT BASEBAND	● RECORDED VOICE
						PCM/PM/FM 1.024 Mc SUBCARRIER	● RECORDED CSM PCM TELEMETRY AT APPARENT 51.2 KILOBITS/SECOND
						FM AT BASEBAND	● RECORDED LEM 1.6 KILOBITS /SECOND PCM TELEMETRY AT APPARENT 51.2 KILOBITS/SECOND
TELEVISION TO MSFN	FM TRANSMITTER #1		S-BAND			FM AT BASEBAND	● SEE "VOICE COMMUNICATIONS WITH MSFN"
TO MSFN	FM TRANSMITTER #2		S-BAND			FM AT BASEBAND	● SEE "TELEMETRY TO MSFN"
UP-DATA (SEE NOTE 4) FROM MSFN	PM TRANSPONDER			S-BAND		PSK/FM/PM 70 Kc SUBCARRIER	● SEE "VOICE COMMUNICATIONS WITH MSFN" ● SUBCODED 5-BIT WORDS AT 1000 BITS/SECOND
TRACKING AID TO MSFN	PM TRANSPONDER		S-BAND	S-BAND		PM RECEIVE- PRN CODE AT BASEBAND PM TRANSMIT- PRN CODE AT BASEBAND	● SEE "VOICE COMMUNICATIONS WITH MSFN" ● COHERENT TURN-AROUND CARRIER ● COHERENT TURN-AROUND RANGE CODE

3/1/66

NOTES:

1. THE MINIMUM WORD INTELLIGIBILITY SHALL BE 90% FOR NORMAL VOICE COMMUNICATIONS AND 70% FOR BACK-UP COMMUNICATIONS AS MEASURED BY USER PERSONNEL UNDER SIMULATED OPERATING CONDITIONS UTILIZING THE AMERICAN STANDARD METHOD FOR MEASUREMENT OF MONOSYLLABIC WORD INTELLIGIBILITY DATED MAY 25, 1960

2. THE TELEMETRY SUBSYSTEM SHALL BE DESIGNED TO PROVIDE AN ERROR RATE NOT EXCEEDING ONE BIT IN 10^6 BITS FOR PCM TELEMETRY TRANSMISSIONS TO STATIONS OF THE MSFN AS MEASURED FROM CSM ENCODER TO MSFN DECODER.

3. THE PCM TELEMETRY SUBSYSTEM SHALL BE CAPABLE OF TRANSMITTING THE PCM BIT STREAM REQUIRED FOR REAL-TIME USE VIA COAXIAL CABLE TO THE CHECKOUT FACILITY IN THE MILA PRIOR TO LIFT-OFF AND VIA AN RF LINK PRIOR TO AND AFTER LIFT-OFF.

4. THE UP-DATA SUBSYSTEM SHALL BE DESIGNED IN CONJUNCTION WITH STATIONS OF THE MSFN SUCH THAT NO MORE THAN ONE CORRECT MESSAGE SHALL BE REJECTED PER 1000 CORRECT MESSAGES AND THAT NO MORE THAN ONE PER 10^9 INCORRECT MESSAGES SHALL BE ACCEPTED.

LEGEND

EQUIPMENT/FUNCTION THIS FLIGHT	EQUIPMENT/FUNCTION LUNAR MISSION	CODING
REQUIRED	REQUIRED	
REQUIRED	NOT REQUIRED	
NOT REQUIRED	REQUIRED	
NOT REQUIRED	NOT REQUIRED	

TABLE 3. 5 - 4A
LEM COMMUNICATIONS AND TRACKING REQUIREMENTS

SUBSYSTEM	EQUIPMENT IMPLEMENTATION	NUMBER OF UNITS	OPERATING FREQUENCY		ANTENNA SUBSYSTEM	MODULATION CHARACTERISTICS	REMARKS
			TRANSMIT	RECEIVE			
VOICE COMMUNICATIONS (SEE NOTE 1) WITH MSFN	UNIFIED S-BAND SYSTEM						• SEE TABLE 3.5-4B FOR REQUIREMENTS
WITH MSFN	VHF TRANSCEIVER #1						• UTILIZED FOR VOICE TRANSMISSION SIMULATION DURING R & D FLIGHT PROGRAM • SEE "VOICE COMMUNICATIONS WITH CSM"
WITH MSFN	VHF TRANSCEIVER #2						• UTILIZED FOR VOICE AND DATA TRANSMISSION DURING R & D FLIGHT PROGRAM • SEE "VOICE COMMUNICATIONS WITH CSM"
WITH CSM	VHF TRANSCEIVER #1	ONE	VHF	VHF	OMNI-DIRECTIONAL	DSBAM TRANSMIT DSBAM RECEIVE	• PRIMARY VOICE COMMUNICATIONS CHANNEL WITH CSM VIA SIMPLEX MODE • TRANSMITTER UTILIZED FOR DUPLEX VOICE COMMUNICATIONS WITH EVA • TRANSCEIVER UTILIZED IN BACK-UP MODE FOR SIMPLEX VOICE COMMUNICATIONS WITH EVA
WITH CSM	VHF TRANSCEIVER #2	ONE	VHF	VHF	MULTIPLEXED WITH TRANSCEIVER #1	DSBAM TRANSMIT DSBAM RECEIVE	• BACK-UP VOICE COMMUNICATIONS CHANNEL WITH CSM VIA SIMPLEX MODE • TRANSMITS LEM PCM/AM DATA TO CSM • RECEIVER UTILIZED FOR DUPLEX VOICE COMMUNICATIONS WITH EVA • RECEIVES EVA BIOMEDICAL DATA SIMULTANEOUSLY WITH EVA VOICE • TRANSCEIVER UTILIZED IN BACK-UP MODE FOR SIMPLEX VOICE COMMUNICATIONS WITH EVA
WITH EVA	VHF TRANSCEIVER #1						• SEE "VOICE COMMUNICATIONS WITH CSM"
WITH EVA	VHF TRANSCEIVER #2						• SEE "VOICE COMMUNICATIONS WITH CSM"
KEYING COMMUNICATIONS TO MSFN	UNIFIED S-BAND SYSTEM						• SEE TABLE 3.5-4B FOR REQUIREMENTS
TELEMETRY TO MSFN	UNIFIED S-BAND SYSTEM						• SEE TABLE 3.5-4B FOR REQUIREMENTS
TO MSFN	VHF TELEMETER	ONE	225-260 Mc		R & D OMNI-DIRECTIONAL SUBSYSTEM ON LEM AND ON ADAPTER	PAM/FM/FM	• SEE NOTE 3
TO MSFN	VHF TELEMETER	ONE	225-260 Mc		MULTIPLEXED ON VHF R & D TELEMETRY ANTENNA SUB-SYSTEM	PAM/FM/FM	• SEE NOTE 3
TO MSFN	VHF TELEMETER	ONE	225-260 Mc		MULTIPLEXED ON VHF R & D TELEMETRY ANTENNA SUB-SYSTEM	PAM/FM/FM	• SEE NOTE 3
TO MSFN	VHF TELEMETER	ONE	225-260 Mc		MULTIPLEXED ON VHF R & D TELEMETRY ANTENNA SUB-SYSTEM	FM/FM	• CONSTANT BANDWIDTH SYSTEM
TO MSFN	VHF TELEMETER	ONE	225-260 Mc		MULTIPLEXED ON VHF R & D TELEMETRY ANTENNA SUB-SYSTEM	PCM/FM	• SEE NOTES 2, 3, AND 4 • REDUNDANT WITH UNIFIED S-BAND SYSTEM PCM LINK
TO MSFN	VHF TRANSCEIVER #2						• UTILIZED FOR DATA TRANSMISSION SIMULATION DURING R & D PROGRAM • SEE "VOICE COMMUNICATIONS WITH CSM"
TO CSM	VHF TRANSCEIVER #2					PCM/AM	• SEE NOTE 5 • PCM BIT RATE OF 1.6 KILOBITS/SECOND • SEE "VOICE COMMUNICATIONS WITH CSM"
FROM EVA	VHF TRANSCEIVER #2					FM/AM	• SEE "VOICE COMMUNICATIONS WITH CSM"
TAPE PLAYBACK TO MSFN							• NOT APPLICABLE
TELEVISION TO MSFN	UNIFIED S-BAND SYSTEM						• SEE TABLE 3.5-4B FOR REQUIREMENTS
UP-DATA (SEE NOTE 6) FROM MSFN	RECEIVER AND DECODER	ONE		400-450 Mc	UTILIZES VHF R & D TELEMETRY ANTENNA SUBSYSTEM	PSK/FM	• UTILIZED ONLY DURING R & D FLIGHT PROGRAM
TRACKING AID TO MSFN	UNIFIED S-BAND SYSTEM						• SEE TABLE 3.5-4B FOR REQUIREMENTS
TO MSFN	C-BAND RADAR TRANSPONDER	TWO	C-BAND	C-BAND	OMNI-DIRECTIONAL	PULSE	• SAME CODING IS UTILIZED FOR BOTH TRANSPONDERS BUT CODING DIFFERS FROM THAT USED BY CSM AND LAUNCH VEHICLE
TRACKING OF CSM	RENDEZVOUS RADAR	TWO	X-BAND	X-BAND	DIRECTIONAL	PM TRANSMIT PM RECEIVE	• THREE-TONE RANGE CODE AND CARRIER COHERENT TURN-AROUND • ACCURACY: (a) VELOCITY 1/4% OR 1 fps (b) RANGE 1% OR 20 feet (c) ANGLE 8mr bias 2mr random • ALSO USED FOR TRACKING OF TRACKING AID ON LUNAR SURFACE
OF TRACKING AID ON LUNAR SURFACE	RENDEZVOUS RADAR						• SEE "TRACKING OF CSM"
OF LUNAR SURFACE	LANDING RADAR	ONE	X-BAND	X-BAND	DIRECTIONAL	CW AND FM/CW TRANSMIT	• ACCURACY: (a) VELOCITY 1% OR 1 fps (b) RANGE 1% OR 5 feet

3/1/66

NOTES:

1. THE MINIMUM WORD INTELLIGIBILITY SHALL BE 90% FOR NORMAL VOICE COMMUNICATIONS AND 70% FOR BACK-UP COMMUNICATIONS AS MEASURED BY USER PERSONNEL UNDER SIMULATED OPERATING CONDITIONS UTILIZING THE AMERICAN STANDARD METHOD FOR MEASUREMENT OF MONOSYLLABIC WORD INTELLIGIBILITY DATED MAY 25, 1960.

2. THE TELEMETRY SUBSYSTEM SHALL BE DESIGNED TO PROVIDE AN ERROR RATE NOT EXCEEDING ONE BIT IN 10^6 BITS FOR PCM TELEMETRY TRANSMISSIONS TO STATIONS OF THE MSFN AS MEASURED FROM LEM ENCODER TO MSFN DECODER.

3. THE TELEMETRY SUBSYSTEMS SHALL BE COMPATIBLE WITH THE INTER RANGE INSTRUMENTATION GROUP STANDARDS (IRIG DOCUMENT NO. 106-60 "TELEMETRY STANDARDS REVISED 1962") APPROPRIATE TO THE RESPECTIVE TELEMETRY SUBSYSTEMS.

4. THIS PCM TELEMETRY SUBSYSTEM SHALL BE CAPABLE OF TRANSMITTING THE PCM BIT STREAM REQUIRED FOR REAL-TIME USE VIA COAXIAL CABLE TO THE CHECKOUT FACILITY IN THE MILA PRIOR TO LIFT-OFF AND VIA AN RF LINK AFTER ADAPTER JETTISON.

5. THE TELEMETRY SUBSYSTEM SHALL BE DESIGNED TO PROVIDE AN ERROR RATE NOT EXCEEDING ONE BIT IN 10^6 BITS FOR PCM TELEMETRY TRANSMISSIONS TO THE CSM AS MEASURED FROM LEM ENCODER TO CSM RECORDER.

6. NO MORE THAN ONE CORRECT MESSAGE SHALL BE REJECTED PER 1000 CORRECT MESSAGES AND THAT NO MORE THAN ONE PER 10^9 INCORRECT MESSAGES SHALL BE ACCEPTED.

LEGEND

EQUIPMENT/FUNCTION		CODING
THIS FLIGHT	LUNAR MISSION	
REQUIRED	REQUIRED	
REQUIRED	NOT REQUIRED	
NOT REQUIRED	REQUIRED	
NOT REQUIRED	NOT REQUIRED	

TABLE 3.5-4B

LEM UNIFIED S-BAND COMMUNICATIONS AND TRACKING REQUIREMENTS

SUBSYSTEM	EQUIPMENT IMPLEMENTATION	NUMBER OF UNITS	OPERATING FREQUENCY TRANSMIT	OPERATING FREQUENCY RECEIVE	ANTENNA SUBSYSTEM	MODULATION CHARACTERISTICS	REMARKS
VOICE COMMUNICATION (SEE NOTE 1) WITH MSFN	TRANSPONDER (PM)	TWO	S-BAND	S-BAND	OMNI-DIRECTIONAL DIRECTIONAL - VARIABLE BEAMWIDTH	FM/PM TRANSMIT - 1.25 Mc SUBCARRIER FM/PM RECEIVE 30 Kc SUBCARRIER	• TRANSPONDER FREQUENCY SHALL BE COHERENT WITH SIGNALS RECEIVED FROM THE MSFN AND IN THE RATIO OF 240:221 • TRANSPONDER ALSO PROVIDES FOR TELEMETRY TRANSMISSION, KEYED TRANSMISSION, AND TRACKING ASSISTANCE TO THE MSFN • RELAY VOICE AND TELEMETRY COMMUNICATIONS WITH EVA • BACK-UP RELAY OF VOICE COMMUNICATIONS BETWEEN MSFN AND CSM
						PM TRANSMIT AT BASEBAND	• EMERGENCY VOICE TRANSMISSION TRANSMITTED ALONE
WITH MSFN	TRANSMITTER (FM)	ONE	S-BAND		ERECTABLE (ON LUNAR SURFACE)	FM/FM TRANSMIT 1.25 Mc SUBCARRIER	• THE FM TRANSMITTER IS NOT REQUIRED TO OPERATE SIMULTANEOUSLY WITH THE PM TRANSPONDER • VOICE RECEPTION IS ACHIEVED VIA PM RECEPTION OF 30 Kc FM SUBCARRIER • TRANSMITTER ALSO PROVIDES FOR TELEMETRY AND TELEVISION TRANSMISSION TO THE MSFN • TRANSMITTER SHALL UTILIZE TRANSPONDER ANTENNA SUBSYSTEM DURING R&D FLIGHT PROGRAM.
KEYING COMMUNICATIONS TO MSFN	TRANSPONDER (PM)		S-BAND			AM/PM 512 Kc SUBCARRIER	• SEE "VOICE COMMUNICATIONS WITH MSFN" • TRANSMITTED ALONE - BACK-UP FOR VOICE TRANSMISSION
TELEMETRY TO MSFN	TRANSMITTER (FM)		S-BAND			PCM/PM/FM 1.024 Mc SUBCARRIER NRZ-C SERIAL BIT STREAM	• SEE "VOICE COMMUNICATIONS WITH MSFN" • SELECTABLE BIT RATES OF 51.2 KILOBITS/SECOND AND 1.6 KILOBITS/SECOND • SEE NOTES 2 AND 3
						FM/FM/FM 7 SUBCARRIERS ON 1.25 Mc VOICE SUBCARRIER	• SEE "VOICE COMMUNICATIONS WITH MSFN" • RELAY OF COMPOSITE EVA VOICE AND 7 CHANNELS OF EVA TELEMETRY ON VOICE SUBCARRIER
TO MSFN	TRANSPONDER (PM)		S-BAND			PCM/PM/PM 1.024 Mc SUBCARRIER NRZ-C SERIAL BIT STREAM	• SEE "VOICE COMMUNICATIONS WITH MSFN" • SELECTABLE BIT RATES OF 51.2 KILOBITS/SECOND AND 1.6 KILOBITS/SECOND • SEE NOTES 2 AND 3
						FM/FM/PM 7 SUBCARRIERS ON 1.25 Mc VOICE SUBCARRIER	• SEE "VOICE COMMUNICATIONS WITH MSFN" • RELAY OF COMPOSITE EVA VOICE AND 7 CHANNELS OF EVA TELEMETRY ON VOICE SUBCARRIER
							• SCIENTIFIC DATA
TAPE PLAYBACK							• NOT APPLICABLE
TELEVISION TO MSFN	TRANSMITTER (FM)		S-BAND			FM AT BASEBAND	• SEE "VOICE COMMUNICATIONS WITH MSFN"
UP-DATA							• NOT APPLICABLE
TRACKING AID TO MSFN	TRANSPONDER (PM)		S-BAND	S-BAND		PM RECEIVE- PRN CODE AT BASEBAND PM TRANSMIT- PRN CODE AT BASEBAND	• SEE "VOICE COMMUNICATIONS WITH MSFN" • COHERENT TURN-AROUND CARRIER • COHERENT TURN-AROUND RANGE CODE

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NOTES:

1. THE MINIMUM WORK INTELLIGIBILITY SHALL BE 90% FOR NORMAL VOICE COMMUNICATIONS AND 70% FOR BACK-UP COMMUNICATIONS AS MEASURED BY USER PERSONNEL UNDER SIMULATED OPERATING CONDITIONS UTILIZING THE AMERICAN STANDARD METHOD FOR MEASUREMENT OF MONOSYLLABIC WORD INTELLIGIBILITY DATED MAY 25, 1960

2. THE TELEMETRY SUBSYSTEM SHALL BE DESIGNED TO PROVIDE AN ERROR RATE NOT EXCEEDING ONE BIT IN 10^6 BITS FOR PCM TELEMETRY TRANSMISSIONS TO STATIONS OF THE MSFN AS MEASURED FROM CSM ENCODER TO MSFN DECODER.

3. THIS PCM TELEMETRY SUBSYSTEM SHALL BE CAPABLE OF TRANSMITTING THE PCM BIT STREAM REQUIRED FOR REAL-TIME USE VIA COAXIAL CABLE TO THE CHECKOUT FACILITY IN THE MILA PRIOR TO LIFT-OFF AND VIA AN RF LINK AFTER ADAPTER JETTISON.

LEGEND

EQUIPMENT/FUNCTION THIS FLIGHT	EQUIPMENT/FUNCTION LUNAR MISSION	CODING
REQUIRED	REQUIRED	
REQUIRED	NOT REQUIRED	
NOT REQUIRED	REQUIRED	
NOT REQUIRED	NOT REQUIRED	

TABLE 3.5-4B

TABLE 3.7-1

REQUIRED CSM COVERAGE

LUNAR LANDING MISSION

SUBSYSTEM \ PHASE	S-IC BURN	S-II BURN	S-IVB BURN	INSERTION + 3 MIN.	INSERTION + 5 MIN.	ORBIT #1	ORBIT #2	ORBIT #3	ORBIT #4 (1)	PRE-INJECTION CHECK-OUT (2)	INJECTION BURN (-1 to +3 MIN.)	POST INJECTION (to +15 MIN.)	TRANS-POSITION (+15 MIN. to 2 HRS)
CSM VHF													
VOICE	Continuous	Continuous	Continuous	Continuous	Continuous	Partial (3)	Partial (3)	Partial (3)	Partial	Continuous	Continuous (4)		
CSM S-BAND													
VOICE	Continuous	Continuous	Continuous	Continuous	Continuous	Partial (3)	Partial (3)	Partial (3)	Partial	Continuous	Continuous (4)	Partial (5)	Continuous
TELEMETRY	Continuous	Continuous	Continuous	Continuous	Continuous	Partial (3)	Partial (3)	Partial (3)	Partial	Continuous	Continuous (4)	Partial (5)	Continuous
UP-DATA	Continuous	Continuous	Continuous	Continuous	Continuous	Partial (3)	Partial (3)	Partial (3)	Partial	Continuous		Partial (5)	Continuous
TRACKING	Continuous	Continuous	Continuous	Continuous	Continuous	Partial (3)	Partial (3)	Partial (3)	Partial	Continuous		Partial (5)	Continuous
TELEVISION						Partial	Partial	Partial					

SUBSYSTEM \ PHASE	TRANSLUNAR COAST	MID-COURSE BURNS	LUNAR ORBIT INSERTION	LUNAR ORBIT	LEM SEPARATION AND DESCENT	LUNAR SURFACE OPERATIONS	LEM ASCENT AND RENDEZVOUS	LEM JETTISON	TRANSEARTH INJECTION	TRANSEARTH	PRE-ENTRY	CM ENTRY
CSM VHF												
VOICE												
CSM S-BAND												
VOICE	Continuous	Continuous		Continuous except when behind the moon	Continuous except when behind the moon	Continuous except when behind the moon	Continuous except when behind the moon	Continuous except when behind the moon		Continuous	Partial	Partial
TELEMETRY	Continuous	Continuous		Continuous except when behind the moon	Continuous except when behind the moon	Continuous except when behind the moon	Continuous except when behind the moon	Continuous except when behind the moon		Continuous	Partial	Partial
UP-DATA	Continuous			Continuous except when behind the moon	Continuous except when behind the moon	Continuous except when behind the moon	Continuous except when behind the moon	Continuous except when behind the moon		Continuous	Partial	
TRACKING	Continuous	Continuous		Continuous except when behind the moon	Continuous except when behind the moon	Continuous except when behind the moon	Continuous except when behind the moon	Continuous except when behind the moon		Continuous	Partial	Partial
TELEVISION	Continuous											

NOTES:

1. CONTINGENCY ORBIT IF INJECTION NOT ATTEMPTED.
2. THIS REQUIREMENT CAN BE SATISFIED DURING THE ORBITAL CONTACTS BEFORE INJECTION.
3. GAP BETWEEN CONTACTS SHALL BE NO GREATER THAN 1/2 ORBIT. CONTACTS SHALL BE AT LEAST 3 MINUTES LONG.
4. COVERAGE CAN BE PROVIDED BY AIRCRAFT.
5. CONTINUOUS COVERAGE FOR A MINIMUM OF 8 MINUTES.

3/1/66

- PARTIAL
- CONTINUOUS EXCEPT WHEN BEHIND THE MOON
- CONTINUOUS
- NOT REQUIRED

TABLE 3.7-2
REQUIRED LEM COVERAGE
LUNAR LANDING MISSION

SUBSYSTEM \ PHASE	TRANSLUNAR COAST	MID-COURSE CORRECTION	LUNAR ORBIT INSERTION	LUNAR ORBIT	LEM SEPARATION AND DESCENT	LUNAR SURFACE OPERATIONS	LEM ASCENT AND RENDEZVOUS	LEM JETTISON
LEM S-BAND								
VOICE	Continuous (1)			Continuous except when behind the moon	Continuous except when behind the moon	Continuous	Continuous except when behind the moon	
TELEMETRY	Continuous (1)			Continuous except when behind the moon	Continuous except when behind the moon	Continuous	Continuous except when behind the moon	Partial
TRACKING	Continuous (1)			Continuous except when behind the moon	Continuous except when behind the moon	Continuous	Continuous except when behind the moon	Partial
TELEVISION						Continuous		

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NOTE:

1. DURING THE NOMINAL MISSION, THERE EXISTS NO REQUIREMENT FOR LEM-MSFN COMMUNICATIONS DURING THE TRANSLUNAR PHASE; HOWEVER, THE CAPABILITY FOR CONTINUOUS VOICE, TELEMETRY AND TRACKING COVERAGE SHALL BE PROVIDED BY THE MSFN.

- PARTIAL
- CONTINUOUS EXCEPT WHEN BEHIND THE MOON
- CONTINUOUS
- NOT REQUIRED

TABLE 3.7 - 1

TABLE 3.7 - 2

TABLE 3.7-3

REQUIRED SATURN V LAUNCH VEHICLE COVERAGE

LUNAR LANDING MISSION

SUBSYSTEM \ PHASE	S-IC BURN	S-II BURN	S-IVB BURN	INSERTION + 3 MIN.	INSERTION + 5 MIN.	ORBIT #1	ORBIT #2	ORBIT #3	ORBIT #4 [5]	PRE-INJECTION CHECK-OUT [6]	INJECTION BURN (-1 to +3 MIN.)	POST INJECTION (to +15 MIN.)	TRANSPOSITION (+15 MIN. to 2 HRS.)
LAUNCH VEHICLE TELEMETRY													
S-IC VHF	CONTINUOUS [1]												
S-II VHF	CONTINUOUS	CONTINUOUS [1]											
S-IVB VHF	CONTINUOUS	CONTINUOUS	CONTINUOUS	CONTINUOUS	CONTINUOUS	PARTIAL [2]	PARTIAL	PARTIAL	PARTIAL	CONTINUOUS	CONTINUOUS [3]		
IU VHF	CONTINUOUS	CONTINUOUS	CONTINUOUS	CONTINUOUS	CONTINUOUS	PARTIAL [2]	PARTIAL	PARTIAL	PARTIAL	CONTINUOUS	CONTINUOUS [3]		
IU S-BAND	CONTINUOUS	CONTINUOUS	CONTINUOUS	CONTINUOUS	CONTINUOUS	PARTIAL [2]	PARTIAL	PARTIAL	PARTIAL	CONTINUOUS	CONTINUOUS [3]	CONTINUOUS [4]	CONTINUOUS
IU CCS	CONTINUOUS	CONTINUOUS	CONTINUOUS	CONTINUOUS	CONTINUOUS	PARTIAL [2]	PARTIAL	PARTIAL	PARTIAL	CONTINUOUS	CONTINUOUS [3]	CONTINUOUS [4]	CONTINUOUS
LAUNCH VEHICLE UP-DATA													
IU CCS	PARTIAL	PARTIAL	PARTIAL	CONTINUOUS	CONTINUOUS	PARTIAL [2]	PARTIAL	PARTIAL	PARTIAL	CONTINUOUS		PARTIAL	CONTINUOUS
LAUNCH VEHICLE COMMAND DESTRUCT													
S-IC	CONTINUOUS [9]												
S-II	CONTINUOUS	PARTIAL [9]											
S-IVB	CONTINUOUS	PARTIAL	PARTIAL [9]										
LAUNCH VEHICLE TRACKING													
IU CCS	PARTIAL	PARTIAL	PARTIAL	CONTINUOUS		PARTIAL [2]	PARTIAL	PARTIAL	PARTIAL	CONTINUOUS [8]		PARTIAL	PARTIAL
IU C-BAND	CONTINUOUS	CONTINUOUS [7]	CONTINUOUS	CONTINUOUS		PARTIAL [2]	PARTIAL	PARTIAL	PARTIAL	CONTINUOUS [8]		PARTIAL	
AZUSA	PARTIAL	PARTIAL [7]	PARTIAL										
ODOP	PARTIAL [7]												

1 COVERAGE SHALL CONTINUE FOR AT LEAST ONE MINUTE AFTER THE END OF BURN.

2 GAP BETWEEN CONTACTS SHALL BE NO GREATER THAN 1/2 ORBIT. CONTACTS SHALL BE AT LEAST 3 MINUTES LONG.

3 COVERAGE CAN BE PROVIDED BY AIRCRAFT.

4 CONTINUOUS COVERAGE FOR A MINIMUM OF 8 MINUTES.

5 CONTINGENCY ORBIT IF INJECTION NOT ATTEMPTED.

6 THIS REQUIREMENT CAN BE SATISFIED DURING THE ORBITAL CONTACTS BEFORE INJECTION.

7 TWO LAUNCH VEHICLE TRANSPONDERS SHALL BE TRACKED CONTINUOUSLY TO SATISFY RANGE REQUIREMENTS.

8 THIS REQUIREMENT CAN BE SATISFIED BY EITHER IU CCS OR IU C-BAND.

9 CONTINUOUS COVERAGE UNTIL THE PREDICTED IMPACT POINT OF THE VEHICLE IS OUTSIDE AREAS SPECIFIED BY RANGE SAFETY.

3/1/66

PARTIAL

CONTINUOUS

NOT REQUIRED

TABLE 3.7-3

TABLE 3. 7-4

REQUIRED SATURN IB LAUNCH VEHICLE COVERAGE

SUBSYSTEM \ PHASE	S-IB BURN	S-IVB BURN	INSERTION +3 MIN.	INSERTION +5 MIN.	COAST	CHECKOUT S-IVB/IU	TRANSPOSITION AND SEPARATION IN EARTH ORBIT	POST SEPARATION IN EARTH ORBIT
VHF TELEMETRY								
S-IB	Continuous 1							
S-IVB	Continuous	Continuous	Continuous	Continuous	Partial 2	Continuous	Partial 3	Partial 3
IU	Continuous	Continuous	Continuous	Continuous	Partial 2	Continuous	Partial 3	Partial 3
COMMAND DESTRUCT								
S-IB	Continuous 4							
S-IVB	Continuous	Partial 4						
UHF UP-DATA								
IU	Partial	Partial	Continuous	Continuous	Partial 2	Continuous	Partial 3	Partial 3
TRACKING								
C-BAND	Continuous	Continuous 5	Continuous	Continuous	Partial 2	Continuous	Partial 3	Partial 3
ODOP	Partial 5							
AZUSA	Partial	Partial 5						

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1 COVERAGE SHALL CONTINUE FOR AT LEAST ONE MINUTE AFTER THE END OF BURN

2 AT LEAST ONE THREE MINUTE CONTACT FOR EACH ORBIT OF THE EARTH PARKING ORBIT PHASE

3 AT LEAST ONE THREE MINUTE CONTACT DURING THIS PHASE

4 CONTINUOUS COVERAGE UNTIL THE PREDICTED IMPACT POINT OF THE VEHICLE IS OUTSIDE AREAS SPECIFIED BY RANGE SAFETY

5 TWO LAUNCH VEHICLE TRANSPONDERS SHALL BE TRACKED CONTINUOUSLY TO SATISFY RANGE SAFETY REQUIREMENTS.

PARTIAL COVERAGE

CONTINUOUS COVERAGE

NOT REQUIRED

10.1.1 General This appendix establishes control weights for the Saturn IB and Saturn V launch vehicles and Apollo spacecraft.

Where a trajectory has been established for the flight missions presented in the Apollo Flight Mission Assignments directive, M-D MA 500-11, control weights are based on that trajectory. Where a mission trajectory has not been established, orbital or lunar mission capability is given as defined in 10.1.3 or in 10.1.4.

10.1.2 Definition of Terms

Control Point: Any designated portion of a space vehicle for which weights are specified in this document.

Control Weight: The limiting value of weight, capacity or capability of a control point based on a specified mission. The established weights shall not be exceeded and the established tank capacity and payload capability shall be guaranteed values.

Dry Weight: The weight of hardware not including fluids except those of sealed closed-loop systems which are installed as single complete items. This weight is the sum of Mass Properties Standard CM 018-001-1 Functional Code items 1 through 16 or equivalent.

Payload Capability: The guaranteed payload (spacecraft injected weight) that the launch vehicle will carry as specified under "Launch Vehicle Payload Requirements", 10.1.3 and 10.1.4.

Injected Inert Weight: The spacecraft module's weight at the time of spacecraft separation from the launch vehicle, excluding usable propellant.

Injection Weight:	The weight of a launch vehicle stage at the time of placing the spacecraft on the desired trajectory.
Propellant Tank Capacity:	The design mainstage propellants, i.e., the amount of usable propellants for which stage or module propellant tanks are sized.
Separation Weight:	The weight of an expended launch vehicle stage as it separates from a flight stage.
Usable Propellants:	The propellants loaded for a specified mission for providing velocity changes. Mass Properties Standard CM 018-001-1 Functional Code number 23 or equivalent.

10.1.3 Saturn IB Launch Vehicle Payload Requirements The Saturn IB launch vehicle shall:

10.1.3.1 Vehicle Number 201

Be capable of meeting the requirements in the Apollo Program Specification, Appendix AS-201 including:

a. Placing a spacecraft (CSM and Adapter) of 37,400 lbs gross weight on a trajectory with a total energy of $-3.9 \times 10^8 ft^2/sec^2$, angular momentum of $4.9 \times 10^{11} ft^2/sec$ and with S-IVB cutoff occurring during ascending flight at an altitude between 800,000 and 1,100,000 ft.

b. Carrying the control weight LES until 25 seconds (nominal) after the S-IB/S-IVB stage separation command.

c. Orienting and stabilizing the spacecraft at its proper attitude (to within S-IVB attitude control deadband accuracy) prior to S-IVB/CSM separation.

10.1.3.2 Vehicle Number 202

Be capable of meeting the requirements in the Apollo Program Specification, Appendix AS-202 including:

a. Placing a spacecraft (CSM and Adapter) of 47,600 lbs gross weight on a trajectory with a total energy of $-4.13 \times 10^8 ft^2/sec^2$, angular momentum of $4.7 \times 10^{11} ft^2/sec$ and with S-IVB cutoff occurring during ascending flight at an altitude between 700,000 and 1,000,000 ft.

b. Carrying the control weight LES until 25 seconds (nominal) after the S-IB/S-IVB stage separation command.

10.1.3.3 Vehicle Number 203

Be capable of meeting the requirements in the Apollo Program Specification, Appendix AS-203 including:

a. Injecting the S-IVB containing 19,410 pounds of LH_2 into a 100 nautical mile circular Earth orbit.

b. Orienting and stabilizing in Earth orbit.

10.1.3.4 Vehicle Number 204

Be capable of meeting the requirements in the Apollo Program Specification, Appendix AS-204 including:

a. Injecting the guaranteed payload into an elliptical Earth orbit of 85/130 nautical miles.

b. Carrying the control weight LES until 25 seconds (nominal) after the S-IB/S-IVB stage separation command.

c. Stabilizing the space vehicle in Earth orbit.

10.1.3.5 Vehicle Number 205

Be capable of meeting the requirements in the Apollo Program Specification, Appendix AS-205 including:

a. Injecting the guaranteed payload into an elliptical Earth orbit of 85/130 nautical miles.

b. Carrying the control weight LES until 25 seconds (nominal) after the S-IB/S-IVB stage separation command.

c. Stabilizing the space vehicle in Earth orbit.

10.1.3.6 Vehicle Number 206

Be capable of meeting the requirements in the Apollo Program Specification, Appendix AS-206 including:

a. Injecting the guaranteed payload into an elliptical Earth orbit of 85/120 nautical miles.

b. Carrying a Boilerplate CSM and LES of 8,580 pounds until 25 seconds (nominal) after the S-IB/S-IVB stage separation command.

c. Stabilizing the space vehicle in Earth orbit.

10.1.3.7 Vehicles Number 207 through 212

Be capable of meeting the requirements in the Apollo Program Specification, Appendices AS-207 through AS-212 including:

a. Injecting the guaranteed payload into an elliptical Earth orbit of 81/107 nautical miles.

b. Carrying the control weight LES until 25 seconds (nominal) after the S-IB/S-IVB stage separation command.

c. Stabilizing the space vehicle in Earth orbit.

10.1.4 Saturn V Launch Vehicle Payload Requirements

10.1.4.1 The Saturn V launch vehicle shall be capable of meeting the requirements in the Apollo Program Specification, Section 3.4 including:

a. Injecting the guaranteed payload into a translunar trajectory of total energy $-8.05 \times 10^6 ft^2/sec^2$ (a nominal 72 hour translunar trajectory with the Moon at the mean Earth-Moon distance) after inserting into a 105 nautical mile circular Earth parking orbit.

b. Providing an additional 260 fps to accommodate:

   (1) any free return trajectory, and

   (2) injection into a lunar transfer trajectory on either of two successive Earth orbits.

c. Carrying the control weight LES until 36 seconds (nominal) after S-IC outboard engine cutoff.

d. Launching over the extremes of launch azimuth specified.

e. Maneuvering in Earth orbit.

f. Stabilizing during transposition and docking.

[redacted]

TABLE 10.1 - 1

SATURN IB CONTROL WEIGHTS

CONTROL POINT	ITEM	CONTROL WEIGHT (lbs.)						
		201	202	203	204	205	206	207 THRU 212
S-IB	DRY WEIGHT	94,448	94,448	88,783	87,000	85,800	85,800	85,800
	PROPELLANT TANK CAPACITY	883,000	883,000	883,000	884,000	884,000	884,000	884,000
	SEPARATION WEIGHT	106,020	105,600	99,695	97,385	96,185	96,229	96,229
S-IB/S-IVB INTERSTAGE	TOTAL WEIGHT	7,000	7,000	7,000	6,600	6,600	6,600	6,600
S-IVB	DRY WEIGHT	25,154	25,154	27,000	24,281	23,353	23,200	23,200
	PROPELLANT TANK CAPACITY	230,000	230,000	230,000	230,000	230,000	230,000	230,000
	INJECTION WEIGHT (NOTE 1)	27,334	27,396	28,714	26,158	25,230	25,077	25,077
INSTRUMENT UNIT	TOTAL WEIGHT	4,650	4,650	4,650	4,650	4,150	4,150	4,150
LAUNCH VEHICLE	PAYLOAD CAPABILITY (NOTE 2)	37,400 (NOTE 3)	47,600 (NOTE 4)	19,410 (NOTE 5)	35,300 (NOTE 6)	35,300 (NOTE 7)	37,100 (NOTE 8)	38,100

3/1/66

[redacted]

Note 1 Does not include flight performance reserves.

Note 2 Payload capability based on the Launch Vehicle Payload Requirements given in 10.1.3.

Note 3 Based on Joint Reference Trajectory, Apollo Trajectory Document No. 65-FMP-2 SA 201/AF009 April 26, 1965.

Note 4 Based on Joint Reference Trajectory, Apollo Trajectory Document No. 65-FMP-1 Apollo Mission 202 April 12, 1965.

Note 5 Weight of LH_2 in S-IVB Stage in Orbit.

Note 6 Based on Joint Reference Trajectory Agreements.

Note 7 An additional payload capability of 1600# is available for experiments.

Note 8 An additional payload capability of 600# is available for experiments.

C[redacted]

TABLE 10.1-2

SATURN V CONTROL WEIGHTS

CONTROL POINT	ITEM	CONTROL WEIGHT (lbs.)					
		501	502	503	504 (Note 3)	505 (Note 3)	506 to 525
S-IC	DRY WEIGHT	312,500	312,500	312,500	304,500	304,500	300,000
	PROPELLANT TANK CAPACITY	4,400,000	4,400,000	4,400,000	4,400,000	4,400,000	4,400,000
	SEPARATION WEIGHT	381,518	381,518	381,518	373,518	373,518	369,018
S-IC/S-II INTERSTAGE	TOTAL WEIGHT	14,200	14,200	14,200	14,100	14,100	14,100
S-II	DRY WEIGHT	86,000	86,000	86,300	83,600	83,600	81,900
	PROPELLANT TANK CAPACITY	930,000	930,000	930,000	930,000	930,000	930,000
	SEPARATION WEIGHT	96,259	96,259	96,259	93,839	93,839	92,139
S-II/S-IVB INTERSTAGE	TOTAL WEIGHT	7,700	7,700	7,700	7,700	7,700	7,700
S-IVB	DRY WEIGHT	28,200	28,200	28,200	28,100	28,100	27,400
	PROPELLANT TANK CAPACITY	230,000	230,000	230 000	230,000	230,000	230,000
	INJECTION WEIGHT (Note 1)	30,491	30,491	30,491	30,391	30,391	29,691
INSTRUMENT UNIT	TOTAL WEIGHT	4,650	4,650	4,650	4,650	4,650	4,150
LAUNCH VEHICLE	PAYLOAD CAPABILITY (Note 2)	85,000	85,000	85,000	93,000	93,000	95,000

3/1/66

Note 1 Does not include Flight Performance Reserves.

Note 2 All payload capabilities are based on the Launch Vehicle Payload Requirements given in 10.1.4.

Note 3 The payload capability of vehicles 504 and 505 is 2000 lbs. less than that of operational vehicles because of removable R&D instrumentation.

[redacted]

CO[redacted]

TABLE 10.1-3

APOLLO SPACE CRAFT CONTROL WEIGHTS

SATURN IB MISSIONS

CONTROL POINT	ITEM		CONTROL WEIGHT (lbs) LV-CSM DEVELOPMENT		CSM LONG DURATION OPERATIONS		LEM DEVELOPMENT	CSM-LEM OPERATIONS
	LAUNCH VEHICLE		201	202	204	205	206	207
	SPACECRAFT	CSM	009	011	012	014	BP-30	101
		LEM					1	2
COMMAND MODULE	TOTAL WEIGHT		11,000	11,000	11,000	11,000		11,000
SERVICE MODULE	DRY WEIGHT (NOTE 1) PROPELLANT TANK CAPACITY INJECTED INERT WEIGHT		 45,000 9,200	 45,000 10,200	 45,000 10,200	 45,000 10,200		 41,000 9,285
	USABLE PROPELLANT		13,300	22,500	6,900	6,900		2,000
LEM ASCENT STAGE (NO CREW)	DRY WEIGHT (NOTE 1) PROPELLANT TANK CAPACITY MAIN TANKS RCS TANKS INJECTED INERT WEIGHT USABLE PROPELLANT							 4.922 330 4,825 500
LEM DESCENT STAGE	DRY WEIGHT (NOTE 1) PROPELLANT TANK CAPACITY INJECTED INERT WEIGHT USABLE PROPELLANT							 15,920 3,590 500
ADAPTER	TOTAL WEIGHT		3,900	3,900	3,900	3,900		3,800
LAUNCH ESCAPE SYSTEM	TOTAL WEIGHT		8,200	8,200	8,200	8,200		8,200
SPACECRAFT	LIFT-OFF WEIGHT INJECTED WEIGHT		45,600 37,400	55,800 47,600	40,200 32,000	40,200 32,000		43,700 35,500

UNDER REVISION

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NOTE 1: SPACECRAFT DRY WEIGHTS NOT AVAILABLE

[redacted]

CO[redacted]

TABLE 10.1-4

APOLLO SPACE CRAFT CONTROL WEIGHTS

SATURN V MISSIONS

CONTROL POINT	ITEM		CONTROL WEIGHT (lbs) LV AND HEATSHIELD DEVELOPMENT		CONTROL WEIGHT (lbs) LUNAR MISSIONS & SIMULATIONS	
	LAUNCH VEHICLE		501	502	503	504 & SUBS
	SPACECRAFT	CSM	017	020	102	
		LEM	FTA 1	FTA 2	3	
COMMAND MODULE	TOTAL WEIGHT		11,000	11,000	11,000	11,000
SERVICE MODULE	DRY WEIGHT (NOTE 1)					
	PROPELLANT TANK CAPACITY		45,000	45,000	41,000	41,000
	INJECTED INERT WEIGHT		10,200	10,200	10,200	10,200
	USABLE PROPELLANT		38,510	38,510	38,510	37,000
LEM ASCENT STAGE (NO CREW)	DRY WEIGHT (NOTE 1)					
	PROPELLANT TANK CAPACITY MAIN TANKS		4,922	4,922	4,922	5,020
	RCS TANKS		330	330	330	575
	INJECTED INERT WEIGHT		4,650	4,650	4,650	4,835
	USABLE PROPELLANT		4,325	4,325	4,325	5,075
LEM DESCENT STAGE	DRY WEIGHT (NOTE 1)					
	PROPELLANT TANK CAPACITY		15,920	15,920	15,920	17,360
	INJECTED INERT WEIGHT		3,865	3,865	3,865	4,775
	USABLE PROPELLANT		8,650	8,650	8,650	17,315
ADAPTER	TOTAL WEIGHT		3,800	3,800	3,800	3,800
LAUNCH ESCAPE SYSTEM	TOTAL WEIGHT		8,200	8,200	8,200	8,200
SPACECRAFT	LIFT-OFF WEIGHT		93,200	93,200	93,200	102,200
	INJECTED WEIGHT		85,000	85,000	85,000	94,000 (NOTE 2)

UNDER REVISION (LEM ascent and descent stage values, 501–503)

UNDER REVISION (spacecraft weights, 501–503)

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NOTE 1: SPACECRAFT DRY WEIGHTS ARE NOT AVAILABLE.

NOTE 2: THE ALLOWABLE VALUE OF INJECTED WEIGHT FOR THIS MISSION IS 94,000 POUNDS EXCEPT FOR THE FIRST TWO FLIGHTS FOR WHICH THE VALUE IS LIMITED TO 93,000 POUNDS DUE TO R&D INSTRUMENTATION IN THE LAUNCH VEHICLES.

[redacted]

Apollo Saturn Mission 201

1.0 Scope This appendix to the Apollo Program Specification identifies the performance, design and test requirements which apply to the Program elements to be utilized for Apollo Saturn Mission 201 (AS-201). These requirements are presented in this appendix as deviations to the requirements specified for equipment for the lunar landing mission and the operational version of the Saturn IB launch vehicle and facilities. Unless otherwise noted, the paragraphs in this appendix replace in their entirety the identically numbered paragraphs in the body of the specification.

THIS APPENDIX IS INCLUDED FOR RECORD PURPOSES. IT REFLECTS THE CONFIGURATION OF AS-201 AS FLOWN ON FEBRUARY 26, 1966.

1.1 Applicability No change.[1]

1.2 Change Approval No change.

2.0 Applicable Documents No change.

3.0 Requirements

3.1 Performance

3.1.1 Characteristics

3.1.1.1 General Add: To the extent practicable, the hardware used on AS-201 shall be of the same design as the operational version.

(1) The phrase "no change" is used after a section heading throughout this appendix to mean that the requirement in the body of the specification applies to this mission without change.

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3.1.1.2 Mission Performance

3.1.1.2.1 Mission Mode This Apollo test mission shall be performed using a non-orbital supercircular entry trajectory. For this mission the spacecraft, which includes an unmanned CM and an SM, shall be launched from the Cape Kennedy launch area (LC 34) into the desired trajectory by a Saturn IB launch vehicle consisting of an S-IB first stage, an S-IVB (Saturn IB version) second stage and an IU. The S-IVB/IU will orient the CSM to the proper attitude prior to separation. After CSM separation, the spacecraft propulsion system shall be used to achieve desired entry conditions for a high heat rate test. The CM shall be slowed to a safe landing by aerodynamic braking after separation of the SM, and, during the final phases of the landing sequence, by parachute.

3.1.1.2.2 Mission Command A Mission Control Programmer shall be provided on board the CM to provide all spacecraft commands necessary for accomplishment of the mission. The Mission Control Programmer shall be capable of receiving signals from ground-based personnel as a backup. The MSFN, including ETR stations, shall be used for communications with the space vehicle and for tracking of the space vehicle (those stages of the launch vehicle and those modules of the spacecraft not jettisoned at the particular point in the mission).

3.1.1.2.3 Payload The payload for this mission shall include a CM with a heat shield to be tested under high heat rate entry conditions. The objectives of this mission shall be as identified in Apollo Flight Mission Assignments, M-D MA 500-11.

3.1.1.2.4 Earth Launch Launch capability shall be provided to permit an initial flight azimuth of 105°.

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3.1.1.2.5 Earth Parking Orbit Not applicable, (N/A).[1]

3.1.1.2.6 Injection Opportunities N/A.

3.1.1.2.7 Lunar Landing Accuracy N/A.

3.1.1.2.8 Lunar Exploration N/A.

3.1.1.2.9 Earth Landing The normal Earth landing mode shall be on water. The capability for water and land landing shall be as specified in 3.5.1.24.

3.1.1.2.10 Recovery Delete reference to crew.

3.1.2 Program Definition No change.

3.1.3 Operability

3.1.3.1 Logistics No change.

3.1.3.2 Safety No change.

3.1.3.3 Reliability The numerical reliability values for mission success given in Table 3.1-2 shall be used where applicable for engineering design and as a standard for evaluating test results. The probability of mission success for the S-IB stage shall be at least 0.95.

The preflight phase begins with the decision to start the countdown for launch and ends with launch. The flight phase begins with space vehicle liftoff from the launch pad and terminates with recovery of the CM.

(1) The phrase "not applicable" is used after a section heading throughout this appendix to mean that the requirement in the body of the specification does not apply to this mission.

Apollo Saturn Mission 201

3.2 Program Standards

3.2.1 Natural Environment and Physical Standards No change.

3.2.2 Electromagnetic Interference No change.

3.2.3 Drawing No change.

3.2.4 Configuration Management No change.

3.2.5 Coordinate System Standards No change.

3.2.5 Coordinate System Standards No change.

3.3 Saturn IB Launch Vehicle

3.3.1 General The Saturn IB launch vehicle shall be composed of two stages, S-IB and S-IVB (Saturn IB version), and an IU (Saturn IB version). The control weights shall be as specified for AS-201 in Table 10.1-1, Appendix 10.1. The launch vehicle shall have the capability of orienting and stabilizing the spacecraft at its proper attitude, prior to separation of the CSM from the S-IVB/IU and the Spacecraft Adapter. In addition, the S-IVB stage and the IU shall be capable of meeting the requirements of this specification under the natural environment of terrestrial space as given in 3.0 of M-DE 8020.008B.

3.3.1.1 Payload The launch vehicle shall have the payload capability specified for AS-201 in Table 10.1-1, Appendix 10.1.

3.3.1.2 Standby Time The launch vehicle shall have the capability to stand by in a loaded condition with propellant topping for six hours and still perform the mission.

3.3.1.3 Prelaunch Checkout No change.

3.3.1.4 In-Flight Performance Evaluation No change.

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3.3.1.5 Emergency Detection Subsystem No change except: The EDS shall be an open-loop system. The EDS shall have the capability to shut down the launch vehicle engines upon ground command via the spacecraft command system.

3.3.1.6 Instrumentation An instrumentation subsystem shall be provided in the launch vehicle to permit ground personnel to evaluate launch vehicle performance.

3.3.1.7 Command Destruct No change.

3.3.1.8 Electrical Power No change.

3.3.2 Structure No change.

3.3.2.1 Prelaunch Environment No change.

3.3.2.2 Launch and Flight Environment The launch vehicle shall be capable of being launched in the 90 percentile peak wind conditions given in 2.3.2.3 of M-DE 8020.008B and associated wind shears given in 2.3.2.4 of M-DE 8020.008B. The launch vehicle shall be capable of flight in the 95 percentile quasi-steady state in-flight winds given in 2.3.2.5 of M-DE 8020.008B. In addition, the vehicle shall be capable of flight with 85 percent of the 99 percentile wind shears given in 2.3.2.6 of M-DE 8020.008B, and with 85 percent of the quasi-square wave gust given in 2.3.2.8 of M-DE 8020.008B, both superimposed on the 95 percentile quasi-steady state in-flight winds given in 2.3.2.5 of M-DE 8020.008B.

3.3.3 Propulsion No change except:

The H-1 engine thrust shall be 200,000 ± 6,000 pounds.

The J-2 engine shall provide a nominal vacuum specific impulse of 422 seconds and a minimum vacuum specific impulse of 418 seconds.

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3.3.4 Launch Vehicle Guidance, Navigation and Control

3.3.4.1 General No change.

3.3.4.1.1 No change except:

(b) N/A.

(c) Be capable of guiding the space vehicle into a supercircular lob-type trajectory.

(e) Include a means for checkout of the launch vehicle guidance, navigation and control system on the launch pad.

3.3.4.1.2 N/A.

3.3.5 Saturn IB Launch Vehicle Communications and Tracking

3.3.5.1 General No change.

3.3.5.2 Functional Capability Delete the 4.5-hour operation requirement for all telemetry, tracking aid and up-data subsystems and replace with the requirement that these subsystems shall operate continuously from liftoff to Earth impact.

3.3.5.3 Coverage Capability The Saturn IB Communication and Tracking System shall be able to operate with the MSFN to achieve the coverage specified in Table 3.7-4 (201) of this appendix.

3.3.5.4 Performance The Saturn IB Communication and Tracking System shall meet the requirements specified in Table 3.3-1 (201) of this appendix.

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3.4 Saturn V Launch Vehicle N/A.

3.5 Spacecraft

3.5.1 General The spacecraft shall be composed of a CM, SM, LES and an Adapter. The spacecraft shall be designed to be mated to a Saturn IB launch vehicle.

Spacecraft control weights shall be as specified for AS-201 in Table 10.1-3, Appendix 10.1.

An instrumentation subsystem shall be provided in the spacecraft which shall permit ground personnel to monitor and evaluate spacecraft performance. An onboard Mission Control Programmer shall provide primary spacecraft control.

No equipment or components critical to the completion of the mission shall be dependent on the cabin atmosphere for electrical insulation or thermal conditioning. Only those materials which do not present a fire hazard or emit harmful quantities of atmospheric contaminants when exposed to an oxygen enriched, low pressure environment shall be used in the pressurized inner structural envelope of the CM.

3.5.1.1 through 3.5.1.3 No change.

3.5.1.4 Standby Time The spacecraft shall have the capability to stand by in a loaded condition, after launch vehicle propellant loading, for 6 hours and still perform the mission.

3.5.1.5 Launch and Flight Environment The spacecraft shall be capable of being launched in the 90 percentile peak surface wind conditions given in 2.3.2.3 of M-DE 8020.008B and associated wind shears given in 2.3.2.4 of M-DE 8020.008B. The spacecraft shall be capable of flight in the 95 percentile quasi-steady state in-flight winds given in 2.3.2.5 of M-DE 8020.008B. In addition, the spacecraft shall be capable of flight with 85 percent of the 99 percentile wind shears given in 2.3.2.6 of M-DE 8020.008B, and with 85 percent of the quasi-square wave gust given in 2.3.2.8 of M-DE 8020.008B, both superimposed on the 95 percentile quasi-steady state in-flight winds given in 2.3.2.5 of M-DE 8020.008B.

3.5.1.6 Terrestrial Space Environment The spacecraft shall be capable of operating in the terrestrial space environment as given in Section 3 of M-DE 8020.008B.

3.5.1.7 through 3.5.1.17 N/A.

3.5.1.18 Sterilization No change.

3.5.1.19 through 3.5.1.21 N/A.

3.5.1.22 Entry The CM shall be capable of entry into the Earth's atmosphere to a preselected impact area. This shall be possible for inertial entry velocities up to 29,000 fps at a flight path angle of -8.8°.

3.5.1.23 Aerodynamic Characteristics The CM shall be ballasted into an offset cg configuration which will produce a lift-to-drag ratio of $.34 \pm .04$ at Mach 6. The direction of the lift vector shall be controllable through the use of the attitude control subsystem.

3.5.1.24 Landing No change.

3.5.1.25 Postlanding The CM shall be capable of floating for seven days under condition given in 2.8 of M-DE 8020.008B.

3.5.1.26 Recovery The CM shall be equipped with recovery aids to assist recovery forces in locating it and in effecting recovery of the vehicle.

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3.5.2 Command and Service Module

3.5.2.1 Structure

3.5.2.1.1 Cabin Space N/A. See 3.1.1.1 (AS-201).

3.5.2.1.2 Windows N/A. See 3.1.1.1 (AS-201).

3.5.2.1.3 Ingress and Egress N/A. See 3.1.1.1 (AS-201).

3.5.2.1.4 Docking N/A.

3.5.2.1.5 Thermal Requirements No change.

3.5.2.1.6 Extravehicular Mobility Unit (EMU) Storage N/A.

3.5.2.2 CSM Propulsion

3.5.2.2.1 General Thrust, specific impulse, minimum impulse and propellants for CSM propulsion subsystems shall be as specified in Table 3.5-1 except that SPS thrust shall be 21,500 ± 215 pounds, SPS nominal vacuum specific impulse shall be 311.2 seconds and SPS minimum vacuum specific impulse shall be 307.6 seconds. The service life of propulsion subsystems after pre-mission testing shall allow the engines to be fired for sufficient time to deplete propellants available when all propellant tanks are loaded to the maximum capacity.

3.5.2.2.2 Command Module Reaction Control Subsystem No change except delete provision for dumping unburned propellant.

3.5.2.2.3 Service Module Reaction Control Subsystem No change except delete reference to LEM.

3.5.2.2.4 Service Module Propulsion Subsystem The SPS shall provide thrust for translational maneuvers of the CSM.

3.5.2.3 CSM Communications and Tracking

3.5.2.3.1 General The CSM Communication and Tracking System shall provide the following capabilities:

(a) Simulated voice communications.

(b) Telemetry transmission.

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(c) Tracking aid.

(d) Up-data reception.

(e) Recovery beacon transmission.

3.5.2.3.2 Functional Capability

3.5.2.3.2.1 Voice Communications A single-frequency tone shall be used to simulate voice communication from:

(a) The CSM to the MSFN.

(b) The CSM to the launch complex prior to liftoff.

(c) The CM to the recovery forces.

3.5.2.3.2.2 Telemetry The telemetry subsystem shall be able to:

(a) Transmit operational data from the CSM to the MSFN.

(b) Transmit the data required for postflight analysis.

(c) Operate continuously from liftoff to Earth impact.

3.5.2.3.2.3 Tracking Aid The tracking aid subsystem shall enable the MSFN to track the CSM.

3.5.2.3.2.4 Up-Data The up-data subsystem shall be able to:

(a) Receive data from the MSFN.

(b) Supply up-data verification signals to the MSFN via the CSM telemetry subsystem.

3.5.2.3.2.5 Television N/A.

3.5.2.3.2.6 Recovery Beacon Continuous beacon operation from the CM shall be provided for at least 24 hours after touchdown.

3.5.2.3.3 Coverage Capability

3.5.2.3.3.1 CSM-MSFN The CSM Communication and Tracking System shall be able to operate with the MSFN to achieve the coverage specified in Table 3.7-1 (201) of this appendix.

3.5.2.3.3.2 CSM-LEM N/A.

3.5.2.3.3.3 CSM-EVA N/A.

3.5.2.3.4 Performance The CSM Communication and Tracking System shall meet the requirements specified in Table 3.5-2A (201) of this appendix.

3.5.2.4 Electrical Power Subsystem

3.5.2.4.1 General The CSM EPS shall generate and distribute all of the electrical power required by the CSM during all phases of the flight plus 24 hours of the postlanding recovery period. The source of electrical power shall be batteries both during flight and during the postlanding period.

3.5.2.4.2 Capacity The EPS shall utilize three entry and postlanding batteries and three main bus batteries. Each battery shall have a minimum capacity of 40 amp-hrs.

3.5.2.4.3 and 3.5.2.4.4 N/A.

3.5.2.4.5 and 3.5.2.4.6 No change.

3.5.2.5 Integrated Navigation, Guidance and Control System Section 3.5.2.5 in the body of the specification is replaced in its entirety by the following requirements.

3.5.2.5.1 General The CM Stabilization and Control System (SCS), utilizing commands from the Mission Control Programmer, shall provide the capability for returning the CM to Earth. The SCS shall provide this capability independent of data or commands from the MSFN.

3.5.2.5.1.1 The principal elements of the SCS shall be gyroscopes and an accelerometer rigidly mounted to the CM structure, control electronics and the displays and controls that would normally be needed for crew operation.

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3.5.2.5.1.2 The SCS shall function automatically once initiated.

3.5.2.6 Display and Control Subsystem N/A.

3.5.2.7 Environmental Control Subsystem The CSM shall be equipped with a nonregenerative ECS which shall provide a conditioned atmosphere and thermal control for the pressurized inner structural envelope. The ECS shall also provide thermal control of equipment where needed.

3.5.2.7.1 Atmospheric Supply The CM crew compartment shall be supplied with pure oxygen. Referenced to 70°F dry bulb, the partial pressure of oxygen shall not be less than 180 mm Hg and, after the boost phase, shall not exceed 300 mm Hg. Stored oxygen shall be provided in the CM for use in the event that the initial cabin pressurization is depleted during the flight.

3.5.2.7.1.1 Atmospheric Control No change except delete reference to crew.

3.5.2.7.2 Water Management N/A.

3.5.2.7.3 EMU Support N/A.

3.5.2.8 Crew Equipment N/A.

3.5.3 Lunar Excursion Module N/A.

3.5.4 Launch Escape System

3.5.4.1 The LES shall be capable of removing the CM from a malfunctioning space vehicle without exceeding the structural limit of the CM/LES. It shall provide terminal conditions for the CM which permit safe entry into the lower atmosphere and deployment of the Earth Landing System (ELS).

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3.5.4.2 The LES shall provide abort capability from before liftoff until shortly after second stage ignition when the LES shall be jettisoned. The LES shall be capable of separating from the space vehicle during a normal mission without degrading space vehicle performance.

3.5.4.3 There shall be no provision for automatic initiation of the LES in the abort mode.

3.5.5 Adapter

3.5.5.1 General The Adapter shall structurally and functionally adapt the spacecraft to the launch vehicle. A tie-bar shall be added to the Adapter. This tie-bar shall simulate the LEM's contribution to the structural integrity of the Adapter.

3.5.5.2 Access The Adapter shall be designed to provide access to its interior during the prelaunch phase.

3.5.5.3 Deployment The Adapter shall be designed to permit normal CSM/Adapter separation and shall not interfere with launch vehicle or spacecraft communications.

3.5.6 Extravehicular Mobility Unit N/A.

3.5.7 Scientific Payload N/A.

3.5.8 Flight Crew Training Equipment N/A.

3.6 Launch Area Only the requirements which are identified with LC 34 and the Direct Launch Support Facilities are applicable with the following exceptions:

3.6.3 Support of manned Apollo Saturn IB space vehicle operations shall not be a requirement for this mission. The capability shall be provided to continue those services and operations necessary to support a launch hold of up to 6 hours occurring after completion of propellant loading.

3.6.3.3 (f) N/A.

3.6.5.1 (e) Monitoring astronaut performance shall not be a requirement for this mission.

3.7 Manned Space Flight Network

3.7.1 General No change.

3.7.2 Capability

3.7.2.1 Voice Communications The voice communications subsystem shall enable:

(a) Simulated voice communications between the CSM and the MCC.

(b) Duplex, 4-wire voice communications between MSFN stations and the MCC.

3.7.2.2 Telemetry The telemetry subsystem shall be able to receive:

(a) Operational data from the CSM.

(b) Operational data from each stage of the launch vehicle and the IU simultaneously with (a).

(c) Engineering data from the space vehicle simultaneously with (a) and (b).

3.7.2.3 Tracking The tracking subsystem shall be able to:

(a) Track in angle and range the radar transponders in the IU and CSM during flight.

(b) Track the transponders in the launch vehicle in angle, range and range rate during the launch phase.

(c) "Skin" track the CM during entry.

(d) Provide sampled tracking data for transmission to the MCC and, where required, for on-site computation.

3.7.2.4 Digital Command Communications No change.

3.7.2.5 Television N/A.

3.7.2.6 Display and Control The LEM reference is not applicable.

3.7.2.7 Data Processing No change.

3.7.3 Coverage The MSFN station in the launch area shall be able to support the prelaunch checkout of the space vehicle on the launch pad.

The MSFN shall provide the coverage capabilities for:

(a) The CSM as specified in Table 3.7-1 (201) of this appendix.

(b) The Saturn IB launch vehicle as specified in Table 3.7-4 (201) of this appendix.

3.7.4 Performance The MSFN shall operate with the space vehicle subsystems as specified in 3.3.5 and 3.5.2.3 of this appendix.

During the launch phase, the MSFN, in conjunction with ETR and launch area instrumentation, shall provide the tracking data needed to satisfy requirements for flight control, range safety and engineering data.

The part of the MSFN using equipment operating in C-Band shall provide angular and range data to the maximum design range of that equipment. The errors in the data due to noise shall not exceed 1.0 milliradian for angular measurements or 60 feet for range measurements (one standard deviation values - the errors due to noise are, by definition, Gaussian distributed with zero mean). Bias errors in these measurements shall not exceed twice the value of the errors due to noise.

3.8 Mission Control Center No change except delete 3.8.1 (d).

4.0 Quality Assurance No change.

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TABLE 3.3 - 1

SATURN IB LAUNCH VEHICLE COMMUNICATION AND TRACKING REQUIREMENTS

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STAGE / SUBSYSTEM	EQUIPMENT IMPLEMENTATION	NUMBER OF UNITS	OPERATING FREQUENCY TRANSMIT	OPERATING FREQUENCY RECEIVE	ANTENNA SUBSYSTEM	MODULATION CHARACTERISTICS	REMARKS
S-IB TELEMETRY	PCM/FM TELEMETER	ONE	225-260 Mc		OMNI-DIRECTIONAL	PCM/FM	• SEE NOTES 1, 2 AND 3 • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND
	FM/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF S-IB PCM/FM TELEMETER	FM/FM	• SEE NOTES 1 AND 4 • PAM/FM/FM MODULATION UTILIZED DURING R & D FLIGHT PROGRAM
	PAM/FM/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF S-IB PCM/FM TELEMETER	PAM/FM/FM	• SEE NOTES 1 AND 4
	SS/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF S-IB PCM/FM TELEMETER	SS/FM	• SEE NOTE 4
COMMAND DESTRUCT	RECEIVER AND DECODER	TWO		400-450 Mc	OMNI-DIRECTIONAL		• THIS SYSTEM SHALL BE COMPATIBLE WITH RANGE SAFETY COMMAND TRANSMITTERS INSTALLED AT STATIONS OF THE ETR.
TRACKING	ODOP TRANSPONDER	ONE	UHF	UHF	FIXED DIRECTIONAL		
S-IVB TELEMETRY	PCM/FM TELEMETER	ONE	225-260 Mc		OMNI-DIRECTIONAL	PCM/FM	• SEE NOTES 1, 2 AND 3 • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND
	FM/FM TELEMETER [6]	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF S-IVB PCM/FM TELEMETER	FM/FM	• SEE NOTES 1 AND 4 • PAM/FM/FM MODULATION UTILIZED DURING R & D FLIGHT PROGRAM
	PAM/FM/FM TELEMETER	TWO	225-260 Mc		SEE NOTE 5	PAM/FM/FM	• SEE NOTES 1 AND 4
	SS/FM TELEMETER	ONE	225-260 Mc		SEE NOTE 5	SS/FM	• SEE NOTE 4
COMMAND DESTRUCT	RECEIVER AND DECODER	TWO		400-450 Mc	OMNI-DIRECTIONAL		• THIS SYSTEM SHALL BE COMPATIBLE WITH RANGE SAFETY COMMAND TRANSMITTERS INSTALLED AT STATIONS OF THE ETR.
INSTRUMENT UNIT TELEMETRY	PCM/FM TELEMETER	ONE	225-260 Mc		OMNI-DIRECTIONAL	PCM/FM	• SEE NOTES 1, 2 AND 3 • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND • BIT STREAM SHALL CONTAIN ALL S-IVB/IU MISSION CONTROL DATA
	PCM/FM TELEMETER	ONE	2100-2300 Mc			PCM/FM	• SEE NOTES 1, 2 AND 3 • EXPERIMENTAL SYSTEM • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND • BIT STREAM SHALL BE IDENTICAL WITH IU VHF PCM/FM TELEMETER
	FM/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF IU VHF PCM/FM TELEMETER	FM/FM	• SEE NOTES 1 AND 4
	PAM/FM/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF IU VHF PCM/FM TELEMETER	PAM/FM/FM	• SEE NOTES 1 AND 4
	SS/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF IU VHF PCM/FM TELEMETER	SS/FM	• SEE NOTE 4
UP-DATA	RECEIVER & DECODER	ONE		400-450 Mc	OMNI-DIRECTIONAL	PSK/FM	• SUBCODED 5-BIT WORDS AT 1000 BITS/SECOND • SEE NOTE 7
COMMAND DESTRUCT (EXPERIMENTAL)	RECEIVER AND DECODER	ONE		400-450 Mc	OMNI-DIRECTIONAL		• THIS SYSTEM SHALL BE COMPATIBLE WITH RANGE SAFETY COMMAND TRANSMITTERS INSTALLED AT STATIONS OF THE ETR. • PASSENGER TEST SA-201 ONLY
TRACKING	C-BAND RADAR TRANSPONDER	ONE	C-BAND	C-BAND	OMNI-DIRECTIONAL	PULSE	• UTILIZES CODING DIFFERENT FROM C-BAND RADAR TRANSPONDERS ON SPACECRAFT
	AZUSA TRANSPONDER	ONE	C-BAND	C-BAND	OMNI-DIRECTIONAL	FM	
TELEVISION	TELEVISION TRANSMITTER	ONE					

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NOTES:

1. THIS TELEMETRY SUBSYSTEM SHALL BE COMPATIBLE WITH THE INTER RANGE INSTRUMENTATION GROUP STANDARDS (IRIG DOCUMENT NO. 106-60. "TELEMETRY STANDARDS REVISED 1962")

2. ALL PCM TELEMETRY SUBSYSTEMS SHALL BE DESIGNED TO PROVIDE AN ERROR RATE NOT EXCEEDING ONE BIT IN 10^6 BITS FOR TRANSMISSIONS TO THE MSFN AS MEASURED FROM LAUNCH VEHICLE ENCODER TO EARTH-BASED DECODER.

3. THIS PCM TELEMETRY SUBSYSTEM SHALL BE CAPABLE OF TRANSMITTING THE PCM BIT STREAM REQUIRED FOR REAL-TIME USE VIA COAXIAL CABLE TO THE CHECKOUT FACILITY PRIOR TO LIFT-OFF AND VIA AN RF LINK PRIOR TO AND AFTER LIFT-OFF.

4. THIS TELEMETRY SUBSYSTEM SHALL TRANSMIT DATA REQUIRED ONLY FOR POST-MISSION ANALYSIS VIA AN RF LINK.

5. UP TO 4 VHF STAGE TELEMETERS SHALL BE MULTIPLEXED ON A COMMON ANTENNA SUBSYSTEM. WHEN MORE THAN 4 VHF STAGE TELEMETERS ARE CARRIED, A SECOND OMNI-DIRECTIONAL ANTENNA SUBSYSTEM SHALL BE PROVIDED.

6. NOT PRESENTLY SCHEDULED FOR OPERATIONAL SATURN IB LAUNCH VEHICLES. HOWEVER, PROVISIONS TO CARRY THIS TELEMETER SHALL BE INCORPORATED ON ALL SATURN IB LAUNCH VEHICLES THROUGH AS-207.

7. THE UP-DATA SUBSYSTEM SHALL BE DESIGNED IN CONJUNCTION WITH STATIONS OF THE MSFN SUCH THAT NO MORE THAN ONE CORRECT MESSAGE SHALL BE REJECTED PER 1000 CORRECT MESSAGES AND THAT NO MORE THAN ONE PER 10^9 INCORRECT MESSAGES SHALL BE ACCEPTED.

EQUIPMENT/FUNCTION THIS FLIGHT	EQUIPMENT/FUNCTION OPERATIONAL VEHICLE	CODING
REQUIRED	REQUIRED	
REQUIRED	NOT REQUIRED	
NOT REQUIRED	REQUIRED	
NOT REQUIRED	NOT REQUIRED	

TABLE 3.3-1
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TABLE 3.5-2A

CSM COMMUNICATIONS AND TRACKING REQUIREMENTS

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SUBSYSTEM	EQUIPMENT IMPLEMENTATION	NUMBER OF UNITS	OPERATING FREQUENCY		ANTENNA SUBSYSTEM	MODULATION CHARACTERISTICS	REMARKS
			TRANSMIT	RECEIVE			
VOICE COMMUNICATIONS WITH MSFN	UNIFIED S-BAND SYSTEM						• SEE TABLE 3.5-2B FOR REQUIREMENTS
(SEE NOTE 1) WITH MSFN[7]	VHF TRANSCEIVER #1	ONE	VHF	VHF	OMNI-DIRECTIONAL	DSBAM TRANSMIT DSBAM RECEIVE	• ALTERNATE NEAR-EARTH VOICE COMMUNICATIONS CHANNEL VIA SIMPLEX MODE OF OPERATION • PRIMARY VOICE COMMUNICATIONS CHANNEL WITH LEM VIA SIMPLEX MODE OF OPERATION • PRIMARY TRANSMITTER FOR DUPLEX VOICE COMMUNICATIONS WITH EVA • ALTERNATE BACK-UP FOR VOICE COMMUNICATIONS WITH EVA VIA SIMPLEX MODE OF OPERATION • ALTERNATE VOICE COMMUNICATIONS CHANNEL WITH RECOVERY FORCES VIA SIMPLEX MODE OF OPERATION
WITH MSFN	VHF TRANSCEIVER #2				MULTIPLEXED WITH TRANSCEIVER #1	DSBAM TRANSMIT DSBAM RECEIVE	• UTILIZED FOR VOICE RECEPTION SIMULATION DURING R & D FLIGHT PROGRAM • SEE "VOICE COMMUNICATIONS WITH LEM"
WITH LEM	VHF TRANSCEIVER #1						• SEE "VOICE COMMUNICATIONS WITH MSFN"
WITH LEM	VHF TRANSCEIVER #2	ONE	VHF	VHF	MULTIPLEXED WITH TRANSCEIVER #1	DSBAM TRANSMIT DSBAM RECEIVE	• BACK-UP VOICE COMMUNICATIONS CHANNEL WITH LEM VIA SIMPLEX MODE OF OPERATION • RECEIVES LEM PCM/AM DATA • PRIMARY RECEIVER FOR DUPLEX VOICE COMMUNICATIONS WITH EVA • RECEIVES EVA BIOMEDICAL DATA SIMULTANEOUSLY WITH EVA VOICE • ALTERNATE BACK-UP FOR VOICE COMMUNICATIONS WITH EVA VIA SIMPLEX MODE OF OPERATIONS
WITH EVA	VHF TRANSCEIVER #1						• SEE "VOICE COMMUNICATIONS WITH MSFN"
WITH EVA	VHF TRANSCEIVER #2						• SEE "VOICE COMMUNICATIONS WITH LEM"
WITH RECOVERY FORCES	HF TRANSCEIVER	ONE	HF	HF	OMNI-DIRECTIONAL	AM, CW, SSB[8]	• ALSO PROVIDES BEACON MODE OF OPERATION FOR DF AFTER LANDING • HF RECOVERY ANTENNA DEPLOYED AFTER LANDING • OPERATES ONLY IN BEACON MODE ON AS-201
WITH RECOVERY FORCES	SURVIVAL TRANSCEIVER	ONE	VHF	VHF	UTILIZES EITHER VHF RECOVERY ANTENNA	AM[7]	• PART OF CREW SURVIVAL EQUIPMENT • BACK-UP FOR VHF VOICE COMMUNICATIONS WITH RECOVERY FORCES • BACK-UP FOR VHF RECOVERY BEACON • OPERATES ONLY IN BEACON MODE ON AS-201 • UTILIZES RECOVERY ANTENNA #2 ON AS-201
WITH RECOVERY FORCES	VHF TRANSCEIVER #1				OMNI-DIRECTIONAL RECOVERY ANTENNA #2		• RECOVERY ANTENNA DEPLOYED AT MAIN CHUTE DEPLOYMENT • SEE "VOICE COMMUNICATIONS WITH MSFN" • NOT UTILIZED IN THIS MODE ON AS-201
KEYING COMMUNICATIONS TO MSFN	UNIFIED S-BAND SYSTEM						• SEE TABLE 3.5-2B FOR REQUIREMENTS
TELEMETRY TO MSFN	UNIFIED S-BAND SYSTEM						• SEE TABLE 3.5-2B FOR REQUIREMENTS
TO MSFN	PCM/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH TRANSCEIVER #1	PCM/FM NRZ-C SERIAL BIT STREAM	• SEE NOTES 2, 3, AND 5 • SELECTABLE BIT RATES OF 51.2 KBS AND 1.6 KBS • ALSO PROVIDES PLAYBACK OF RECORDED CSM PCM TELEMETRY • 51.2 KBS BIT RATE UTILIZED ON AS-201
TO MSFN	PAM/FM/FM TELEMETER	TWO	225-260 Mc		MULTIPLEXED WITH TRANSCEIVER #1	PAM/FM/FM	• TRANSMIT DATA REQUIRED ONLY FOR POST-FLIGHT ANALYSIS • SEE NOTE 3
TO MSFN	FM TELEMETER	ONE	225-260 Mc			PCM/FM OR FM/FM	• TRANSMITS DATA REQUIRED ONLY FOR POST-FLIGHT ANALYSIS • SEE NOTE 3
FROM LEM	VHF TRANSCEIVER #2					PCM/AM	• SEE "VOICE COMMUNICATIONS WITH LEM" • SEE NOTE 4 • PCM BIT RATE OF 1.6 KILOBITS/SECOND
FROM EVA	VHF TRANSCEIVER #2					FM/AM	• SEE "VOICE COMMUNICATIONS WITH LEM"
TAPE PLAYBACK TO MSFN	UNIFIED S-BAND SYSTEM						• SEE TABLE 3.5-2B FOR REQUIREMENTS
TO MSFN	PCM/FM TELEMETER						• SEE "TELEMETRY TO MSFN"
TELEVISION TO MSFN	UNIFIED S-BAND SYSTEM						• SEE TABLE 3.5-2B FOR REQUIREMENTS
UP-DATA FROM MSFN	UNIFIED S-BAND SYSTEM						• SEE TABLE 3.5-2B FOR REQUIREMENTS
FROM MSFN	RECEIVER AND DECODER	ONE		400-450 Mc	UTILIZES TRANSCEIVER #1 IN-FLIGHT ANTENNA	PSK/FM FM	• SUBCODED 5-BIT WORDS AT 1000 BITS/SECOND • SEE NOTE 6 • TONE-SYSTEM ON AS-201
TRACKING AID TO MSFN	UNIFIED S-BAND SYSTEM						• SEE TABLE 3.5-2B FOR REQUIREMENTS
TO MSFN	C-BAND RADAR TRANSPONDER	ONE	C-BAND	C-BAND	OMNI-DIRECTIONAL	PULSE	• UTILIZES CODING DIFFERENT FROM LAUNCH VEHICLE AND LEM C-BAND RADAR TRANSPONDERS
TO LEM	RENDEZVOUS RADAR TRANSPONDER	ONE	X-BAND	X-BAND	OMNI-DIRECTIONAL	PM RECEIVE PM TRANSMIT	• THREE-TONE RANGE CODE AND COHERENT CARRIER TURN-AROUND
BEACON TO RECOVERY FORCES	RECOVERY BEACON	ONE	VHF		OMNI-DIRECTIONAL RECOVERY ANTENNA #1	AM	• RECOVERY ANTENNA DEPLOYED AT MAIN CHUTE DEPLOYMENT
TO RECOVERY FORCES	HF TRANSCEIVER					CW	• SEE "VOICE COMMUNICATIONS WITH RECOVERY FORCES"
TO RECOVERY FORCES	SURVIVAL TRANSCEIVER					AM	• SEE "VOICE COMMUNICATIONS WITH MSFN"

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NOTES:

1. THE MINIMUM WORD INTELLIGIBILITY SHALL BE 90% FOR NORMAL VOICE COMMUNICATIONS AND 70% FOR BACK-UP COMMUNICATIONS AS MEASURED BY USING PERSONNEL UNDER SIMULATED OPERATING CONDITIONS UTILIZING THE AMERICAN STANDARD METHOD FOR MEASUREMENT OF MONOSYLLABIC WORD INTELLIGIBILITY DATED MAY 25, 1960.
2. THE TELEMETRY SUBSYSTEM SHALL BE DESIGNED TO PROVIDE AN ERROR RATE NOT EXCEEDING ONE BIT IN 10^6 BITS FOR TRANSMISSIONS TO THE MSFN AS MEASURED FORM CSM ENCODER TO MSFN DECODER.
3. THIS TELEMETRY SUBSYSTEM SHALL BE COMPATIBLE WITH THE INTER RANGE INSTRUMENTATION GROUP STANDARDS (IRIG DOCUMENT NO. 106-60, "TELEMETRY STANDARDS REVISED 1962")
4. THE TELEMETRY SUBSYSTEM SHALL BE DESIGNED TO PROVIDE AN [illegible] RATE NOT EXCEEDING ONE BIT IN [illegible] FOR PCM TELEMETRY TRANSMISS[illegible] THE CSM AS MEASURED FROM LEM ENCODER TO THE CSM RECORDER.
5. THIS PCM TELEMETRY SUBSYSTEM SHALL BE CAPABLE OF TRANSMITTING THE PCM BIT STREAM REQUIRED FOR REAL-TIME USE VIA COAXIAL CABLE TO THE CHECKOUT FACILITY IN THE MILA PRIOR TO LIFT-OFF AND VIA AN RF LINK PRIOR TO AND AFTER LIFT-OFF.
6. NO MORE THAN ONE [illegible]ECT MESSAGE SHALL BE REJECTED PER [illegible] CORRECT MESSAGES AND NO MORE TH[illegible] PER 10^9 INCORRECT MESSAGES SHALL [illegible] ACCEPTED.
7. TRANSMITS SINGLE FREQUENCY TONE ON AS-201
8. TRANSMITS CW ON AS-201

N/A ON AS-201

LEGEND

EQUIPMENT/FUNCTION		CODING
THIS FLIGHT	LUNAR MISSION	
REQUIRED	REQUIRED	
REQUIRED	NOT REQUIRED	
NOT REQUIRED	REQUIRED	
NOT REQUIRED	NOT REQUIRED	

TABLE 3.5-2A

APOLLO-SATURN 201

APPENDIX 201
TABLE 3.7-1
REQUIRED CSM COVERAGE
APOLLO-SATURN 201

SUBSYSTEM \ PHASE	S-IB BURN	S-IVB BURN	END OF S-IVB BURN +3 MINUTES	END OF S-IVB BURN +5 MINUTES	COAST	SPS BURNS	CM SEPARATION	CM ENTRY
VHF								
SIMULATED VOICE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	PARTIAL COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	PARTIAL COVERAGE
TELEMETRY	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	PARTIAL COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	PARTIAL COVERAGE
UHF								
UP-DATA	PARTIAL COVERAGE	PARTIAL COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	PARTIAL COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	PARTIAL COVERAGE
C-BAND								
TRACKING	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	NOT REQUIRED	PARTIAL COVERAGE	CONTINUOUS COVERAGE	NOT REQUIRED	PARTIAL COVERAGE

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PARTIAL COVERAGE

CONTINUOUS COVERAGE

NOT REQUIRED

TABLE 3.7-1
APOLLO-SATURN 201

APPENDIX 201
TABLE 3.7-4
REQUIRED SATURN IB LAUNCH VEHICLE COVERAGE
APOLLO-SATURN 201

SUBSYSTEM \ PHASE	S-IB BURN	S-IVB BURN	END OF S-IVB BURN +3 MINUTES	COAST
VHF TELEMETRY				
S-IB	CONTINUOUS COVERAGE 1			
S-IVB	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	PARTIAL COVERAGE
IU	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	PARTIAL COVERAGE
COMMAND DESTRUCT				
S-IB	CONTINUOUS COVERAGE 2			
S-IVB	CONTINUOUS COVERAGE	PARTIAL COVERAGE 2		
EXPERIMENTAL COMMAND DESTRUCT				
IU	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	PARTIAL COVERAGE
TRACKING				
C-BAND	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE 3	CONTINUOUS COVERAGE	PARTIAL COVERAGE
ODOP	PARTIAL COVERAGE 3			
AZUSA	PARTIAL COVERAGE	PARTIAL COVERAGE 3		

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1 COVERAGE SHALL CONTINUE FOR AT LEAST ONE MINUTE AFTER THE END OF BURN.

2 CONTINUOUS COVERAGE UNTIL THE PREDICTED IMPACT POINT OF THE VEHICLE IS OUTSIDE AREAS SPECIFIED BY RANGE SAFETY.

3 TWO LAUNCH VEHICLE TRANSPONDERS SHALL BE TRACKED CONTINUOUSLY TO SATISFY RANGE SAFETY REQUIREMENTS.

PARTIAL COVERAGE
CONTINUOUS COVERAGE
NOT REQUIRED

Apollo Saturn Mission 202

1.0 Scope This appendix to the Apollo Program Specification identifies the performance, design and test requirements which apply to the Program elements to be utilized for Apollo Saturn Mission 202 (AS-202). These requirements are presented in this appendix as deviations to the requirements specified for equipment for the lunar landing mission and the operational version of the Saturn IB launch vehicle and facilities. Unless otherwise noted, the paragraphs in this appendix replace in their entirety the identically numbered paragraphs in the body of the specification.

1.1 Applicability No change.(1)

1.2 Change Approval No change.

2.0 Applicable Documents No change.

3.0 Requirements

3.1 Performance

3.1.1 Characteristics

3.1.1.1 General Add: To the extent practicable, the hardware used on AS-202 shall be of the same design as the operational version.

(1) The phrase "no change" is used after a section heading throughout this appendix to mean that the requirement in the body of the specification applies to this mission without change.

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3.1.1.2 Mission Performance

3.1.1.2.1 Mission Mode This Apollo test mission shall be performed using a non-orbital supercircular entry trajectory. For this mission the spacecraft, which includes an unmanned CM and an SM, shall be launched from the Cape Kennedy launch area (LC 34) into the desired trajectory by a Saturn IB launch vehicle consisting of an S-IB first stage, an S-IVB (Saturn IB version) second stage and an IU. After CSM separation from the launch vehicle-spacecraft Adapter, the spacecraft propulsion and guidance systems shall be used to achieve desired entry conditions for a high heat load. The CM shall be slowed to a safe landing by aerodynamic braking after separation of the SM, and during the final phases of the landing sequence by parachute.

3.1.1.2.2 Mission Command A Mission Control Programmer shall be provided on board the CM which, in conjunction with the CM guidance computer, shall provide all spacecraft commands necessary for accomplishment of the mission. The Mission Control Programmer shall be capable, independent of the CM guidance computer, of receiving signals from ground-based personnel as a backup. The MSFN, including ETR stations, shall be used for communications with the space vehicle and for tracking the space vehicle (those stages of the launch vehicle and those modules of the spacecraft not jettisoned at the particular point in the mission).

3.1.1.2.3 Payload The payload for this mission shall include a CM with a heat shield to be tested under high heat load entry conditions. The objectives of this mission shall be as identified in Apollo Flight Mission Assignments, M-D MA 500-11.

3.1.1.2.4 Earth Launch Launch capability shall be provided to permit an initial flight azimuth of 105°.

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3.1.1.2.5 Earth Parking Orbit Not applicable (N/A).[2]

3.1.1.2.6 Injection Opportunities N/A.

3.1.1.2.7 Lunar Landing Accuracy N/A.

3.1.1.2.8 Lunar Exploration N/A.

3.1.1.2.9 Earth Landing The normal Earth landing mode shall be on water. The capability for water and land landing shall be as specified in 3.5.1.24.

3.1.1.2.10 Recovery Delete reference to crew.

3.1.2 Program Definition No change.

3.1.3 Operability

3.1.3.1 Logistics No change.

3.1.3.2 Safety No change.

3.1.3.3 Reliability The numerical reliability values for mission success given in Table 3.1-2 shall be used where applicable for engineering design and as a standard for evaluating test results. The probability of mission success for the S-IB stage shall be at least 0.95.

The preflight phase begins with the decision to start the countdown for launch and ends with launch. The flight phase begins with space vehicle liftoff from the launch pad and terminates with recovery of the CM.

(2) The phrase "not applicable" is used after a section heading throughout this appendix to mean that the requirement in the body of the specification does not apply to this mission.

Apollo Saturn Mission 202

3.2 Program Standards No change.

3.3 Saturn IB Launch Vehicle

3.3.1 General The Saturn IB launch vehicle shall be composed of two stages, S-IB and S-IVB (Saturn IB version) and an IU (Saturn IB version). The control weights shall be as specified for AS-202 in Table 10.1-1, Appendix 10.1. The launch vehicle shall have the capability of orienting and stabilizing the spacecraft at its proper attitude prior to separation of the CSM from the S-IVB/IU and the Spacecraft Adapter. In addition, the S-IVB and the IU shall be capable of meeting the requirements of this specification under the natural environment of terrestrial space as given in 3.0 of M-DE 8020.008B.

3.3.1.1 Payload The launch vehicle shall have the payload capability specified for AS-202 in Table 10.1-1, Appendix 10.1.

3.3.1.2 Standby Time No change.

3.3.1.3 Prelaunch Checkout No change.

3.3.1.4 In-Flight Performance Evaluation No change.

3.3.1.5 Emergency Detection Subsystem No change.

3.3.1.6 Instrumentation An instrumentation subsystem shall be provided in the launch vehicle to permit ground personnel to evaluate launch vehicle performance.

3.3.1.7 Command Destruct No change.

3.3.1.8 Electrical Power No change.

3.3.2 Structure No change.

3.3.2.1 Prelaunch Environment No change.

3.3.2.2 Launch and Flight Environment The launch vehicle shall be capable of being launched in the 90 percentile peak surface wind conditions given in 2.3.2.3 of M-DE 8020.008B and associated wind shears given in 2.3.2.4 of M-DE 8020.008B. The launch vehicle shall be capable of flight in the 95 percentile quasi-steady state in-flight winds given in 2.3.2.5 of M-DE 8020.008B. In addition, the vehicle shall be capable of flight with 85 percent of the 99 percentile wind shears given in 2.3.2.6 of M-DE 8020.008B, and with 85 percent of the quasi-square wave gust given in 2.3.2.8 of M-DE 8020.008B, both superimposed on the 95 percentile quasi-steady state in-flight winds given in 2.3.2.5 of M-DE 8020.008B.

3.3.3 Propulsion No change except:

The H-1 engine thrust shall be 200,000 ± 6,000 pounds.

The J-2 engine shall provide a nominal vacuum specific impulse of 422 seconds and a minimum vacuum specific impulse of 418 seconds.

3.3.4 Launch Vehicle Guidance, Navigation and Control No change except:

3.3.4.1.1 (b) N/A.

3.3.4.1.1 (c) Be capable of guiding the space vehicle into a super-circular lob-type trajectory.

3.3.4.1.1 (e) Include a means for checkout of the launch vehicle guidance, navigation and control system on the launch pad.

3.3.4.1.2 N/A.

3.3.5 Saturn IB Launch Vehicle Communications and Tracking

3.3.5.1 General The Communication and Tracking System of the Saturn IB launch vehicle shall have the following capabilities:

(a) Telemetry transmission.

(b) Tracking aid.

(c) Command-destruct data reception.

(d) Television transmission.

3.3.5.2 Functional Capability Delete the 4.5 hour operating requirement for all telemetry and tracking aid subsystems. Replace with the requirement that these systems shall operate continuously from liftoff to Earth impact. Delete the requirement for the up-data subsystem (3.3.5.2.3). Add the following paragraph:

3.3.5.2.5 Television The television subsystem in the IU shall be capable of providing television transmission of the deployment of the Adapter panels to suitably equipped stations of the MSFN within line-of-sight of the IU.

3.3.5.3 Coverage Capability The Saturn IB Communication and Tracking System shall be able to operate with the MSFN to achieve the coverage specified in Table 3.7-4 (202) of this appendix.

3.3.5.4 Performance The Saturn IB Communication and Tracking System shall meet the requirements specified in Table 3.3-1 (202) of this appendix.

3.4 Saturn V Launch Vehicle N/A.

3.5 Spacecraft

3.5.1 General The spacecraft shall be composed of a CM, SM, LES and an Adapter. The spacecraft shall be designed to be mated to a Saturn IB launch vehicle.

Spacecraft control weights shall be as specified for AS-202 in Table 10.1-3, Appendix 10.1.

An instrumentation subsystem shall be provided in the spacecraft which shall permit ground personnel to monitor and evaluate spacecraft performance. The spacecraft shall be capable of utilizing data from Earth-based tracking and computing facilities in conjunction with onboard computations.

No equipment or components critical to the completion of the mission shall be dependent on the cabin atmosphere for electrical insulation or thermal conditioning. Only those materials which do not present a fire hazard or emit harmful quantities of atmospheric contaminants when exposed to an oxygen-enriched, low-pressure environment shall be used in the pressurized inner structural envelope of the CM.

3.5.1.1 through 3.5.1.3 No change.

3.5.1.4 Standby Time The spacecraft shall have the capability to stand by in a loaded condition, after launch vehicle propellant loading, for 10 hours and still perform the mission.

3.5.1.5 Launch and Flight Environment The spacecraft shall be capable of being launched in the 90 percentile peak surface wind conditions given in 2.3.2.3 of M-DE 8020.008B and associated wind shears given in 2.3.2.4 of M-DE 8020.008B. The spacecraft shall be capable of flight in the 95 percentile quasi-steady state in-flight winds given in 2.3.2.5 of M-DE 8020.008B. In addition, the spacecraft shall be capable of flight with 85 percent of the 99 percentile wind shears given in 2.3.2.6 of M-DE 8020.008B, and with 85 percent of the quasi-square wave gust given in 2.3.2.8 of M-DE 8020.008B, both superimposed on the 95 percentile quasi-steady state in-flight winds given in 2.3.2.5 of M-DE 8020.008B.

3.5.1.6 Terrestrial Space Environment The spacecraft shall be capable of operating in the terrestrial space environment as given in Section 3 of M-DE 8020.008B.

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3.5.1.7 through 3.5.1.17 N/A.

3.5.1.18 Sterilization No change.

3.5.1.19 through 3.5.1.21 N/A.

3.5.1.22 Entry The CM shall be capable of controlled flight through the Earth's atmosphere (as given in 2.5 of M-DE 8020.008B) to a preselected impact area having a ground range of 2500 nm from the entry point (defined as the point at which the vehicle first descends through the 400,000 feet altitude level). This shall be possible for a nominal inertial entry velocity of 28,500 fps and a flight path angle of -3.5^{o}. The design limit entry load for all CM systems shall be a 20g deceleration.

3.5.1.23 Aerodynamic Characteristics No change.

3.5.1.24 Landing No change.

3.5.1.25 Postlanding The CM shall be capable of floating for seven days under conditions given in 2.8 of M-DE 8020.008B.

3.5.1.26 Recovery The CM shall be equipped with recovery aids to assist recovery forces in locating it and in effecting recovery of the vehicle.

3.5.2 Command and Service Module

3.5.2.1 Structure

3.5.2.1.1 Cabin Space N/A. See 3.1.1.1 (AS-202).

3.5.2.1.2 Windows N/A. See 3.1.1.1 (AS-202).

3.5.2.1.3 Ingress and Egress N/A. See 3.1.1.1 (AS-202).

3.5.2.1.4 Docking N/A.

3.5.2.1.5 Thermal Requirements No change.

3.5.2.1.6 Extravehicular Mobility Unit (EMU) Storage N/A.

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3.5.2.2 CSM Propulsion

3.5.2.2.1 General Thrust, specific impulse, minimum impulse and propellants for CSM propulsion subsystems shall be as specified in Table 3.5-1 except that SPS thrust shall be 21,500 ± 215 pounds, SPS nominal vacuum specific impulse shall be 311.2 seconds and SPS minimum vacuum specific impulse shall be 307.6 seconds. The service life of propulsion subsystems after pre-mission testing shall allow the engines to be fired for sufficient time to deplete propellants available when all propellant tanks are loaded to the maximum capacity.

3.5.2.2.2 Command Module Reaction Control Subsystem No change except delete provisions for dumping unburned propellant.

3.5.2.2.3 Service Module Reaction Control Subsystem No change except delete reference to LEM.

3.5.2.2.4 Service Module Propulsion Subsystem The SPS shall provide thrust for translational maneuvers of the CSM.

3.5.2.3 CSM Communications and Tracking

3.5.2.3.1 General The CSM Communication and Tracking System shall provide the following capabilities:

(a) Simulated voice communications.

(b) Telemetry transmission.

(c) Tracking aid.

(d) Up-data reception.

(e) Recovery beacon transmission.

3.5.2.3.2 Functional Capability

3.5.2.3.2.1 Voice Communications A single-frequency tone shall be used to simulate voice communication from:

(a) The CSM to the MSFN.

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(b) The CSM to the launch complex prior to liftoff.

(c) The CM to the recovery forces.

3.5.2.3.2.2 Telemetry The telemetry subsystem shall be able to:

(a) Transmit operational data from the CSM to the MSFN.

(b) Transmit the data required for postflight analysis.

(c) Operate continuously from liftoff to Earth impact.

3.5.2.3.2.3 Tracking Aid The tracking aid subsystem shall enable the MSFN to track the CSM.

3.5.2.3.2.4 Up-Data The up-data subsystem shall be able to:

(a) Receive data from the MSFN.

(b) Supply up-data verification signals to the MSFN via the CSM telemetry subsystem.

3.5.2.3.2.5 Television N/A.

3.5.2.3.2.6 Recovery Beacon No change.

3.5.2.3.3 Coverage Capability

3.5.2.3.3.1 CSM-MSFN The CSM Communication and Tracking System shall be able to operate with the MSFN to achieve the coverage specified in Table 3.7-1 (202) of this appendix.

3.5.2.3.3.2 CSM-LEM N/A.

3.5.2.3.3.3 CSM-EVA N/A.

3.5.2.3.4 Performance The CSM Communication and Tracking System shall meet the requirements specified in Table 3.5-2A(202) and Table 3.5-2B (202) of this appendix.

3.5.2.4 Electrical Power Subsystem

3.5.2.4.1 General The CSM EPS shall generate and distribute all of the electrical power required by the CSM during all phases of the flight plus 48 hours of the postlanding recovery period. Until SM separation, the primary source of electrical power shall be fuel cells and batteries. After SM separation, CM power shall be supplied by batteries.

3.5.2.4.2 Nominal Capacity The EPS shall utilize three liquid hydrogen and liquid oxygen fuel cells, and shall be capable of supplying a total of 575 kwh of electrical energy. Each fuel cell shall be capable of supplying power over a range from 565 watts to 1400 watts. In addition to the three entry and postlanding batteries, three 40 amp-hr batteries shall be available to supply extra power required by the mission programmer and R&D instrumentation.

3.5.2.4.3 Sizing N/A.

3.5.2.4.4 Water and Oxygen Supply The EPS shall supply water and oxygen to the ECS.

3.5.2.4.5 and 3.5.2.4.6 No change.

3.5.2.5 Integrated Navigation, Guidance and Control System Section 3.5.2.5 in the body of the specification is replaced in entirety by the following requirements.

3.5.2.5.1 General The Primary Navigation, Guidance and Control System (PNGCS) and the Stabilization and Control System (SCS) shall be used in conjunction with the Mission Control Programmer (MCP) to provide the CSM with the capability of executing the unmanned AS-202 flight sequences, and for returning the CM to the designated landing area. The PNGCS and SCS shall provide CSM guidance and control after CSM separation from the launch vehicle. The MCP and SCS shall provide guidance and control in the event of PNGCS failure.

Spacecraft control during the mission shall be provided by the Apollo Guidance Computer (AGC) in conjunction with the MCP. The AGC shall initiate spacecraft guidance and control functions. As a backup the MCP shall be able to accept discrete ground commands independent of the PNGCS so as to provide spacecraft control.

3.5.2.5.1.1 The principal elements of the PNGCS shall be an IMU, a digital computer, an optical subsystem, and controls.

3.5.2.5.1.2 The principal elements of the SCS shall be gyroscopes, an accelerometer rigidly mounted to the CM structure, control electronics and controls.

3.5.2.5.1.3 The PNGCS shall provide means for checkout on the launch pad utilizing the prelaunch checkout equipment.

3.5.2.5.1.4 The PNGCS shall:

(a) Permit the AGC to accept commands and navigation data from the MSFN via the up-data link.

(b) Provide means for monitoring the position, velocity, attitude and attitude rates of the Apollo space vehicle during burns of the S-IB and S-IVB stages.

(c) Provide for alignment of the SCS inertial attitude reference from the PNGCS.

(d) Provide for prelaunch alignment of the PNGCS IMU.

3.5.2.6 Display and Control Subsystem N/A. See 3.1.1.1 (AS-202).

3.5.2.7 Environmental Control Subsystem The CSM shall be equipped with a nonregenerative Environmental Control Subsystem (ECS) which shall provide a conditioned atmosphere and thermal control for the pressurized inner structural envelope. The ECS shall also provide thermal control of equipment where needed.

3.5.2.7.1 Atmospheric Supply The pressurized inner structural envelope shall be supplied with pure oxygen to maintain a partial pressure of oxygen not less than 180 mm Hg throughout the mission and not more than 300 mm Hg after the launch phase, referenced to 70°F dry bulb. The primary source of oxygen shall be the EPS located in the SM. The ECS shall be capable of maintaining a cabin pressure of not less than 3.5 psia for at least 15 minutes following a 0.25-inch diameter puncture. This capability shall not be required in the CM after SM separation. The ECS shall provide stored oxygen in the CM for use from SM separation to CM touchdown.

3.5.2.7.1.1 Atmospheric Control No change except delete reference to crew.

3.5.2.7.2 Water Management In addition to water loaded on board at launch, the ECS shall receive water from the EPS.

3.5.2.7.3 EMU Support N/A.

3.5.2.8 Crew Equipment N/A.

3.5.3 Lunar Excursion Module N/A.

3.5.4 Launch Escape System

3.5.4.1 The LES shall be capable of removing the CM from a malfunctioning space vehicle without exceeding the structural limit of the CM/LES. It shall provide terminal conditions for the CM which permit safe entry into the lower atmosphere and deployment of the ELS.

3.5.4.2 The LES shall provide abort capability from before liftoff until shortly after second stage ignition when the LES shall be jettisoned. The LES shall be capable of separating from the space vehicle during a normal mission without degrading space vehicle performance.

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3.5.5 Adapter

3.5.5.1 General The Adapter shall structurally and functionally connect the spacecraft to the launch vehicle. A structural stiffener shall be added to the Adapter. This stiffener shall simulate the LEM's contribution to the structural integrity of the Adapter.

3.5.5.2 Access The Adapter shall be designed to provide access to its interior during the prelaunch phase.

3.5.5.3 Deployment The Adapter shall be designed to permit normal CSM/Adapter separation and shall not interfere with launch vehicle or spacecraft communications.

3.5.6 Extravehicular Mobility Unit N/A.

3.5.7 Scientific Payload N/A.

3.5.8 Flight Crew Training Equipment N/A.

3.6 Launch Area Only the requirements which are identified with LC 34 and the Direct Launch Support Facilities are applicable with the following exceptions:

3.6.3 Support of manned Apollo Saturn IB space vehicle operations shall not be a requirement for this mission.

3.6.3.3 (f) N/A.

3.6.5.1 (e) Monitoring astronaut performance shall not be a requirement for this mission.

3.7 Manned Space Flight Network

3.7.1 General No change.

3.7.2 Functional Capability

3.7.2.1 Voice Communications The voice communications subsystem shall enable:

(a) Simulated voice communications between the CSM and the MCC.

(b) Duplex, 4-wire voice communications between MSFN stations and the MCC.

3.7.2.2 Telemetry The telemetry subsystem shall be able to receive:

(a) Operational data from the CSM.

(b) Operational data from each stage of the launch vehicle and the IU simultaneously with (a).

(c) Engineering data from the space vehicle simultaneously with (a) and (b).

3.7.2.3 Tracking The tracking subsystem shall be able to:

(a) Track in angle and range the radar transponders in the IU and CSM during flight.

(b) Track the transponders in the launch vehicle in angle, range and range rate during the launch phase.

(c) Provide sampled tracking data for transmission to the MCC and, where required, for on-site computation.

3.7.2.4 Digital Command Communications No change.

3.7.2.5 Television The television subsystem shall be able to receive, record and display television transmission from the IU locally at the Cape Kennedy and Antigua sites.

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3.7.2.6 Display and Control The LEM reference is not applicable.

3.7.2.7 Data Processing No change.

3.7.2.8 Timing No change.

3.7.3 Coverage Capability The MSFN station in the launch area shall be able to support the prelaunch checkout of the space vehicle on the launch pad.

The MSFN shall provide the coverage capabilities for:

(a) The CSM as specified in Table 3.7-1 (202) of this appendix.

(b) The Saturn IB launch vehicle as specified in Table 3.7-4 (202) of this appendix.

3.7.4 Performance No change except the MSFN shall operate with the space vehicle subsystems as specified in 3.3.5 and 3.5.2.3 of this appendix.

3.8 Mission Control Center No change except delete 3.8.1 (d).

4.0 Quality Assurance No change.

APPENDIX 202

TABLE 3.3 - 1

SATURN IB LAUNCH VEHICLE COMMUNICATION AND TRACKING REQUIREMENTS

APOLLO-SATURN 202

STAGE / SUBSYSTEM	EQUIPMENT IMPLEMENTATION	NUMBER OF UNITS	OPERATING FREQUENCY TRANSMIT	OPERATING FREQUENCY RECEIVE	ANTENNA SUBSYSTEM	MODULATION CHARACTERISTICS	REMARKS
S-IB TELEMETRY	PCM/FM TELEMETER	ONE	225-260 Mc		OMNI-DIRECTIONAL	PCM/FM	• SEE NOTES 1, 2 AND 3 • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND
	FM/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF S-IB PCM/FM TELEMETER	FM/FM	• SEE NOTES 1 AND 4 • PAM/FM/FM MODULATION UTILIZED DURING R & D FLIGHT PROGRAM
	PAM/FM/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF S-IB PCM/FM TELEMETER	PAM/FM/FM	• SEE NOTES 1 AND 4
	SS/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF S-IB PCM/FM TELEMETER	SS/FM	• SEE NOTE 4
COMMAND DESTRUCT	RECEIVER AND DECODER	TWO		400-450 Mc	OMNI-DIRECTIONAL		• THIS SYSTEM SHALL BE COMPATIBLE WITH RANGE SAFETY COMMAND TRANSMITTERS INSTALLED AT STATIONS OF THE ETR.
TRACKING	ODOP TRANSPONDER	ONE	UHF	UHF	FIXED DIRECTIONAL		
S-IVB TELEMETRY	PCM/FM TELEMETER	ONE	225-260 Mc		OMNI-DIRECTIONAL	PCM/FM	• SEE NOTES 1, 2 AND 3 • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND
	FM/FM TELEMETER [6]	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF S-IVB PCM/FM TELEMETER	FM/FM	• SEE NOTES 1 AND 4 • PAM/FM/FM MODULATION UTILIZED DURING R & D FLIGHT PROGRAM
	PAM/FM/FM TELEMETER	TWO	225-260 Mc		SEE NOTE 5	PAM/FM/FM	• SEE NOTES 1 AND 4
	SS/FM TELEMETER	ONE	225-260 Mc		SEE NOTE 5	SS/FM	• SEE NOTE 4
COMMAND DESTRUCT	RECEIVER AND DECODER	TWO		400-450 Mc	OMNI-DIRECTIONAL		• THIS SYSTEM SHALL BE COMPATIBLE WITH RANGE SAFETY COMMAND TRANSMITTERS INSTALLED AT STATIONS OF THE ETR.
INSTRUMENT UNIT TELEMETRY	PCM/FM TELEMETER	ONE	225-260 Mc		OMNI-DIRECTIONAL	PCM/FM	• SEE NOTES 1, 2 AND 3 • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND • BIT STREAM SHALL CONTAIN ALL S-IVB/IU MISSION CONTROL DATA
	PCM/FM TELEMETER	ONE	2100-2300 Mc			PCM/FM	• SEE NOTES 1, 2 AND 3 • EXPERIMENTAL SYSTEM • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND • BIT STREAM SHALL BE IDENTICAL WITH IU VHF PCM/FM TELEMETER
	FM/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF IU VHF PCM/FM TELEMETER	FM/FM	• SEE NOTES 1 AND 4
	PAM/FM/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF IU VHF PCM/FM TELEMETER	PAM/FM/FM	• SEE NOTES 1 AND 4
	SS/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF IU VHF PCM/FM TELEMETER	SS/FM	• SEE NOTE 4
UP-DATA	RECEIVER & DECODER	ONE		400-450 Mc	OMNI-DIRECTIONAL	PSK/FM	• SUBCODED 5-BIT WORDS AT 1000 BITS/SECOND • SEE NOTE 7
COMMAND DESTRUCT (EXPERIMENTAL)	RECEIVER AND DECODER	ONE		400-450 Mc	OMNI-DIRECTIONAL		• THIS SYSTEM SHALL BE COMPATIBLE WITH RANGE SAFETY COMMAND TRANSMITTERS INSTALLED AT STATIONS OF THE ETR. • PASSENGER TEST, SA-201 ONLY
TRACKING	C-BAND RADAR TRANSPONDER	ONE	C-BAND	C-BAND	OMNI-DIRECTIONAL	PULSE	• UTILIZES CODING DIFFERENT FROM C-BAND RADAR TRANSPONDERS ON SPACECRAFT
	AZUSA TRANSPONDER	ONE	C-BAND	C-BAND	OMNI-DIRECTIONAL	FM	
TELEVISION	TELEVISION TRANSMITTER	ONE	850-870 Mc		DIRECTIONAL	FM	• ONE CAMERA WITH A MIRROR ARRANGEMENT WILL VIEW ALL ADAPTER PANELS AND PANEL HINGE POINTS ON AS-202.

3/1/66

NOTES:

1. THIS TELEMETRY SUBSYSTEM SHALL BE COMPATIBLE WITH THE INTER RANGE INSTRUMENTATION GROUP STANDARDS (IRIG DOCUMENT NO. 106-60. "TELEMETRY STANDARDS REVISED 1962")

2. ALL PCM TELEMETRY SUBSYSTEMS SHALL BE DESIGNED TO PROVIDE AN ERROR RATE NOT EXCEEDING ONE BIT IN 10^6 BITS FOR TRANSMISSIONS TO THE MSFN AS MEASURED FROM LAUNCH VEHICLE ENCODER TO EARTH-BASED DECODER.

3. THIS PCM TELEMETRY SUBSYSTEM SHALL BE CAPABLE OF TRANSMITTING THE PCM BIT STREAM REQUIRED FOR REAL-TIME USE VIA COAXIAL CABLE TO THE CHECKOUT FACILITY PRIOR TO LIFT-OFF AND VIA AN RF LINK PRIOR TO AND AFTER LIFT-OFF.

4. THIS TELEMETRY SUBSYSTEM SHALL TRANSMIT DATA REQUIRED ONLY FOR POST-MISSION ANALYSIS VIA AN RF LINK.

5. UP TO 4 VHF STAGE TELEMETERS SHALL BE MULTIPLEXED ON A COMMON ANTENNA SUBSYSTEM. WHEN MORE THAN 4 VHF STAGE TELEMETERS ARE CARRIED, A SECOND OMNI-DIRECTIONAL ANTENNA SUBSYSTEM SHALL BE PROVIDED.

6. NOT PRESENTLY SCHEDULED FOR OPERATIONAL SATURN IB LAUNCH VEHICLES. HOWEVER, PROVISIONS TO CARRY THIS TELEMETER SHALL BE INCORPORATED ON ALL SATURN IB LAUNCH VEHICLES THROUGH AS-207.

7. THE UP-DATA SUBSYSTEM SHALL BE DESIGNED IN CONJUNCTION WITH STATIONS OF THE MSFN SUCH THAT NO MORE THAN ONE CORRECT MESSAGE SHALL BE REJECTED PER 1000 CORRECT MESSAGES AND THAT NO MORE THAN ONE PER 10^9 INCORRECT MESSAGES SHALL BE ACCEPTED.

EQUIPMENT/FUNCTION: THIS FLIGHT	EQUIPMENT/FUNCTION: OPERATIONAL VEHICLE	CODING
REQUIRED	REQUIRED	
REQUIRED	NOT REQUIRED	
NOT REQUIRED	REQUIRED	
NOT REQUIRED	NOT REQUIRED	

TABLE 3.3-1
APOLLO-SATURN 202

APPENDIX 202.

TABLE 3.5-2A

CSM COMMUNICATIONS AND TRACKING REQUIREMENTS

APOLLO-SATURN 202

SUBSYSTEM	EQUIPMENT IMPLEMENTATION	NUMBER OF UNITS	OPERATING FREQUENCY TRANSMIT	OPERATING FREQUENCY RECEIVE	ANTENNA SUBSYSTEM	MODULATION CHARACTERISTICS	REMARKS
VOICE COMMUNICATIONS (SEE NOTE 1)	UNIFIED S-BAND SYSTEM						● SEE TABLE 3.5-2B FOR REQUIREMENTS
WITH MSFN	VHF TRANSCEIVER #1	ONE	VHF	VHF	OMNI-DIRECTIONAL	DSBAM TRANSMIT DSBAM RECEIVE	● ALTERNATE NEAR-EARTH VOICE COMMUNICATIONS CHANNEL VIA SIMPLEX MODE OF OPERATION ● PRIMARY VOICE COMMUNICATIONS CHANNEL WITH LEM VIA SIMPLEX MODE OF OPERATION ● PRIMARY TRANSMITTER FOR DUPLEX VOICE COMMUNICATIONS WITH EVA ● ALTERNATE BACK-UP FOR VOICE COMMUNICATIONS WITH EVA VIA SIMPLEX MODE OF OPERATION ● ALTERNATE VOICE COMMUNICATIONS CHANNEL WITH RECOVERY FORCES VIA SIMPLEX MODE OF OPERATION ● PROVIDES BEACON MODE OF OPERATION FOR DF AFTER LANDING
WITH MSFN	VHF TRANSCEIVER #2		VHF	VHF	MULTIPLEXED WITH TRANSCEIVER #1	DSBAM TRANSMIT DSBAM RECEIVE	● UTILIZED FOR VOICE AND DATA TRANSMISSION SIMULATION DURING R & D FLIGHT PROGRAM ● SEE "VOICE COMMUNICATIONS WITH LEM"
WITH LEM	VHF TRANSCEIVER #1		VHF	VHF			● SEE "VOICE COMMUNICATIONS WITH MSFN"
WITH LEM	VHF TRANSCEIVER #2	ONE	VHF	VHF	MULTIPLEXED WITH TRANSCEIVER #1	DSBAM TRANSMIT DSBAM RECEIVE	● BACK-UP VOICE COMMUNICATIONS CHANNEL WITH LEM VIA SIMPLEX MODE OF OPERATION ● RECEIVES LEM PCM/AM DATA ● PRIMARY RECEIVER FOR DUPLEX VOICE COMMUNICATIONS WITH EVA ● RECEIVES EVA BIOMEDICAL DATA SIMULTANEOUSLY WITH EVA VOICE ● ALTERNATE BACK-UP FOR VOICE COMMUNICATIONS WITH EVA VIA SIMPLEX MODE OF OPERATIONS
WITH EVA	VHF TRANSCEIVER #1		VHF	VHF			● SEE "VOICE COMMUNICATIONS WITH MSFN"
WITH EVA	VHF TRANSCEIVER #2		VHF	VHF			● SEE "VOICE COMMUNICATIONS WITH LEM"
WITH RECOVERY FORCES	HF TRANSCEIVER	ONE	HF	HF	OMNI-DIRECTIONAL	AM, CW, SSB	● PROVIDES BEACON MODE OF OPERATION FOR DF AFTER LANDING ● HF RECOVERY ANTENNA DEPLOYED AFTER LANDING
WITH RECOVERY FORCES	VHF TRANSCEIVER #1		VHF	VHF	MULTIPLEXED WITH VHF BEACON ANTENNA AFTER ENTRY		● SEE "VOICE COMMUNICATIONS WITH MSFN"
KEYING COMMUNICATIONS TO MSFN	UNIFIED S-BAND SYSTEM						● SEE TABLE 3.5-2B FOR REQUIREMENTS
TELEMETRY TO MSFN	UNIFIED S-BAND SYSTEM						● SEE TABLE 3.5-2B FOR REQUIREMENTS
TO MSFN	VHF TRANSCEIVER #2		VHF				● UTILIZED FOR VOICE AND DATA TRANSMISSION SIMULATION DURING R & D FLIGHT PROGRAM ● SEE "VOICE COMMUNICATIONS WITH LEM"
TO MSFN	PCM/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH TRANSCEIVER #1	PCM/FM NRZ-C SERIAL BIT STREAM	● SEE NOTES 2, 3 AND 5 ● SELECTABLE BIT RATES OF 51.2 KILOBITS/SECOND AND 1.6 KILOBITS/SECOND ● ALSO PROVIDES PLAYBACK OF RECORDED CSM PCM TELEMETRY
TO MSFN	PAM/FM/FM TELEMETER	TWO	225-260 Mc		MULTIPLEXED WITH TRANSCEIVER #1	PAM/FM/FM	● TRANSMITS DATA REQUIRED ONLY FOR POST-FLIGHT ANALYSIS ● SEE NOTE 3
TO MSFN	PAM/FM/FM TELEMETER	ONE	225-260 Mc			PAM/FM/FM	● TRANSMITS DATA REQUIRED ONLY FOR POST-FLIGHT ANALYSIS ● SEE NOTE 3
FROM LEM	VHF TRANSCEIVER #2			VHF		PCM/AM	● SEE "VOICE COMMUNICATIONS WITH LEM" ● SEE NOTE 4 ● PCM BIT RATE OF 1.6 KILOBITS/SECOND
FROM EVA	VHF TRANSCEIVER #2			VHF		FM/AM	● SEE "VOICE COMMUNICATIONS WITH LEM"
TAPE PLAYBACK TO MSFN	UNIFIED S-BAND SYSTEM						● SEE TABLE 3.5-2B FOR REQUIREMENTS
TO MSFN	PCM/FM TELEMETER		225-260 Mc				● SEE "TELEMETRY TO MSFN"
TO MSFN	PCM/FM TELEMETER	ONE	225-260 Mc			PCM/FM	● TRANSMITS RECORDED PCM/FM DATA ● SEE NOTES 2, 3 AND 5
TELEVISION TO MSFN	UNIFIED S-BAND SYSTEM						● SEE TABLE 3.5-2B FOR REQUIREMENTS
UP-DATA (SEE NOTE 6) FROM MSFN	UNIFIED S-BAND SYSTEM						● SEE TABLE 3.5-2B FOR REQUIREMENTS
FROM MSFN	RECEIVER AND DECODER	ONE		400-450 Mc	UTILIZES TRANSCEIVER #1 IN-FLIGHT ANTENNA	PSK/FM	● SUBCODED 5-BIT WORDS AT 1000 BITS/SECOND
TRACKING AID TO MSFN	UNIFIED S-BAND SYSTEM						● SEE TABLE 3.5-2B FOR REQUIREMENTS
TO MSFN	C-BAND RADAR TRANSPONDER	ONE	C-BAND	C-BAND	OMNI-DIRECTIONAL	PULSE	● UTILIZES CODING DIFFERENT FROM LAUNCH VEHICLE AND LEM C-BAND RADAR TRANSPONDERS
TO LEM	RENDEZVOUS RADAR TRANSPONDER	ONE	X-BAND	X-BAND	OMNI-DIRECTIONAL	PM RECEIVE PM TRANSMIT	● THREE TONE RANGE CODE AND COHERENT CARRIER TURN-AROUND
BEACON TO RECOVERY FORCES	VHF BEACON	ONE	VHF		OMNI-DIRECTIONAL	AM	● VHF RECOVERY ANTENNA DEPLOYED AT MAIN CHUTE DEPLOYMENT ● BEACON IS MULTIPLEXED WITH TRANSCEIVER #1 AFTER ENTRY
TO RECOVERY FORCES	HF TRANSCEIVER		HF				● SEE "VOICE COMMUNICATIONS WITH RECOVERY FORCES"
TO RECOVERY FORCES	VHF TRANSCEIVER #1		VHF		MULTIPLEXED WITH VHF BEACON ANTENNA AFTER ENTRY		● SEE "VOICE COMMUNICATIONS WITH MSFN"

3/1/66

NOTES:

1. THE MINIMUM WORD INTE[illegible]IGIBILITY SHALL BE 90% FOR NORMAL V[illegible] COMMUNICATIONS AND 70% FOR BACK[illegible]UNICATIONS AS MEASURED BY U[illegible]NNEL UNDER SIMULATED [illegible] CONDITIONS UTILIZING T[illegible]CAN STANDARD METHOD FOR ME[illegible]T OF MONOSYLLABIC WORD INTELLIG[illegible]LITY DATED MAY 25, 1960. N/A ON AS-202

2. THE TELEMETRY SUBSYSTEM SHALL BE DESIGNED TO PROVIDE AN ERROR RATE NOT EXCEEDING ONE BIT IN 10^6 BITS FOR TRANSMISSIONS TO THE MSFN AS MEASURED FORM CSM ENCODER TO MSFN DECODER.

3. THIS TELEMETRY SUBSYSTEM SHALL BE COMPATIBLE WITH THE INTER RANGE INSTRUMENTATION GROUP STANDARDS (IRIG DOCUMENT NO. 106-60, "TELEMETRY STANDARDS REVISED 1962")

4. THE TELEMETRY SUBSYS[illegible] SHALL BE DESIGNED TO PROVIDE A[illegible] NOT EXCEEDING ONE BIT [illegible] TELEMETRY TRANSMIS[illegible] CSM AS MEASURED FROM LEM ENCO[illegible] TO THE CSM RECORDER. N/A ON AS-202

5. THIS PCM TELEMETRY SUBSYSTEM SHALL CAPABLE OF TRANSMITTING THE PCM BIT STREAM REQUIRED FOR REAL-TIME USE VIA COAXIAL CABLE TO THE CHECKOUT FACILITY IN THE MILA PRIOR TO LIFT-OFF AND VIA AN RF LINK PRIOR TO AND AFTER LIFT-OFF.

6. NO MORE THAN ONE CORRECT MESSAGE SHALL BE REJECTED PER 1000 CORRECT MESSAGES AND NO MORE THAN ONE PER 10^9 INCORRECT MESSAGES SHALL BE ACCEPTED.

LEGEND

EQUIPMENT/FUNCTION THIS FLIGHT	EQUIPMENT/FUNCTION LUNAR MISSION	CODING
REQUIRED	REQUIRED	
REQUIRED	NOT REQUIRED	
NOT REQUIRED	REQUIRED	
NOT REQUIRED	NOT REQUIRED	

TABLE 3.5-2A
APOLLO-SATURN 202

APPENDIX 202

TABLE 3.5-2B

CSM UNIFIED S-BAND COMMUNICATIONS AND TRACKING REQUIREMENTS

APOLLO-SATURN 202

SUBSYSTEM	EQUIPMENT IMPLEMENTATION	NUMBER OF UNITS	OPERATING FREQUENCY TRANSMIT	OPERATING FREQUENCY RECEIVE	ANTENNA SUBSYSTEM	MODULATION CHARACTERISTICS	REMARKS
VOICE COMMUNICATIONS (SEE NOTE 1) WITH MSFN	PM TRANSPONDER	TWO	S-BAND	S-BAND	OMNI-DIRECTIONAL DIRECTIONAL VARIABLE BEAMWIDTH	FM/PM TRANSMIT - 1.25 Mc SUBCARRIER FM/PM RECEIVE 30 Kc SUBCARRIER	● TRANSPONDER FREQUENCY SHALL BE COHERENT WITH SIGNALS RECEIVED FROM THE MSFN AND IN THE RATIO OF 240:221 ● RELAY VOICE AND TELEMETRY COMMUNICATIONS WITH EVA ● BACKUP RELAY OF VOICE COMMUNICATIONS WITH LEM ● TRANSPONDER ALSO PROVIDES FOR TELEMETRY TRANSMISSION, KEYED TRANSMISSION, UP-DATA RECEPTION AND TRACKING ASSISTANCE TO THE MSFN.
						PM TRANSMIT AT BASEBAND	● EMERGENCY VOICE TRANSMISSION ● THIS CAPABILITY IS PROVIDED ONLY WHEN THE CAPABILITY FOR SIMULTANEOUS PM AND FM S-BAND TRANSMISSION IS PROVIDED.
						FM/PM RECEIVE 70 Kc SUBCARRIER	● EMERGENCY VOICE RECEPTION ● THIS CAPABILITY IS PROVIDED ONLY WHEN THE CAPABILITY FOR SIMULTANEOUS PM AND FM S BAND TRANSMISSION IS PROVIDED. ● SEE "UP-DATA FROM MSFN
WITH MSFN	FM TRANSMITTER #1	ONE	S-BAND		MULTIPLEXED WITH S-BAND TRANSPONDER OMNI-DIRECTIONAL ANTENNA SYSTEM	FM/FM TRANSMIT 1.25 Mc SUBCARRIER	● THIS TRANSMITTER OPERATES ON THE SAME FREQUENCY AS THE TRANSPONDER, THEREFORE IT IS PROVIDED ONLY ON THOSE FLIGHTS FOR WHICH SIMULTANEOUS PM AND FM S-BAND TRANSMISSION IS NOT REQUIRED. ● VOICE RECEPTION IS ACHIEVED VIA PM RECEPTION OF 30 Kc FM SUBCARRIER. ● TRANSMITTER ALSO PROVIDES FOR TELEMETRY, SCIENTIFIC DATA, TELEVISION, AND TAPE PLAYBACK TRANSMISSION TO THE MSFN.
KEYING COMMUNICATIONS TO MSFN	PM TRANSPONDER		S-BAND			AM/PM 512 Kc SUBCARRIER	● SEE "VOICE COMMUNICATIONS WITH MSFN" ● TRANSMITTED ALONE - BACKUP FOR VOICE TRANSMISSION
TELEMETRY TO MSFN	PM TRANSPONDER		S-BAND			PCM/PM/PM 1.024 Mc SUBCARRIER NRZ-C SERIAL BIT STREAM	● SEE "VOICE COMMUNICATIONS WITH MSFN" ● SELECTABLE BIT RATES OF 51.2 KILOBITS/SECOND AND 1.6 KILOBITS/SECOND ● SEE NOTES 2 AND 3
						FM/FM/PM 7 SUBCARRIERS ON 1.25 Mc VOICE SUBCARRIER	● SEE "VOICE COMMUNICATIONS WITH MSFN" ● RELAY OF COMPOSITE EVA VOICE AND 7 CHANNELS OF EVA TELEMETRY ON VOICE SUBCARRIER WHEN SIMULTANEOUS PM AND FM S-BAND TRANSMISSION CAPABILITY IS PROVIDED.
TO MSFN	FM TRANSMITTER #1		S-BAND			PCM/PM/FM 1.024 Mc SUBCARRIER NRZ-C SERIAL BIT STREAM	● SEE "VOICE COMMUNICATIONS WITH MSFN" ● SELECTABLE BIT RATES OF 51.2 KILOBITS/SECOND AND 1.6 KILOBITS/SECOND ● SEE NOTES 2 AND 3
						FM/FM 95 Kc, 125 Kc, 165 Kc SUBCARRIERS	● SEE "VOICE COMMUNICATIONS WITH MSFN" ● PROVIDES 3 CHANNELS OF REAL TIME SCIENTIFIC DATA TRANSMISSION TO THE MSFN ● SIX ADDITIONAL SUBCARRIERS ARE ALSO AVAILABLE
TO MSFN	FM TRANSMITTER #2	ONE	S-BAND		MULTIPLEXED WITH S-BAND TRANSPONDER ANTENNA SYSTEM	FM/FM 95 Kc, 125 Kc, 165 Kc SUBCARRIERS	● THIS TRANSMITTER IS PROVIDED ONLY ON THOSE FLIGHTS FOR WHICH SIMULTANEOUS PM AND FM S-BAND TRANSMISSION IS REQUIRED. ● TRANSMITTER ALSO PROVIDES FOR TELEVISION AND TAPE PLAYBACK TRANSMISSION TO THE MSFN. ● PROVIDES 3 CHANNELS OF REAL TIME SCIENTIFIC DATA TRANSMISSION TO THE MSFN
TAPE PLAYBACK TO MSFN	FM TRANSMITTER #1		S-BAND				● SEE "VOICE COMMUNICATIONS WITH MSFN"
						FM/FM 95 Kc, 125 Kc, 165 Kc SUBCARRIERS	● RECORDED SCIENTIFIC DATA - 3 CHANNELS ● SIX ADDITIONAL CHANNELS ARE ALSO AVAILABLE
						FM/FM ANALOG SUBCARRIER	● RECORDED VOICE
						PCM/PM/FM 1.024 Mc SUBCARRIER	● RECORDED CSM PCM TELEMETRY AT APPARENT 51.2 KILOBITS/SECOND RATE
TO MSFN	FM TRANSMITTER #2		S-BAND				● SEE "TELEMETRY TO MSFN"
						FM/FM 95 Kc, 125 Kc, 165 Kc SUBCARRIERS	● RECORDED SCIENTIFIC DATA - 3 CHANNELS
						FM AT BASEBAND	● RECORDED VOICE
						PCM/PM/FM 1.024 Mc SUBCARRIER	● RECORDED CSM PCM TELEMETRY AT APPARENT 51.2 KILOBITS/SECOND
						FM AT BASEBAND	● RECORDED LEM 1.6 KILOBITS /SECOND PCM TELEMETRY AT APPARENT 51.2 KILOBITS/SECOND
TELEVISION TO MSFN	FM TRANSMITTER #1		S-BAND			FM AT BASEBAND	● SEE "VOICE COMMUNICATIONS WITH MSFN"
TO MSFN	FM TRANSMITTER #2		S-BAND			FM AT BASEBAND	● SEE "TELEMETRY TO MSFN"
UP-DATA (SEE NOTE 4) FROM MSFN	PM TRANSPONDER			S-BAND		PSK/FM/PM 70 Kc SUBCARRIER	● SEE "VOICE COMMUNICATIONS WITH MSFN" ● SUBCODED 5-BIT WORDS AT 1000 BITS/SECOND
TRACKING AID TO MSFN	PM TRANSPONDER		S-BAND	S-BAND		PM RECEIVE- PRN CODE AT BASEBAND PM TRANSMIT- PRN CODE AT BASEBAND	● SEE "VOICE COMMUNICATIONS WITH MSFN" ● COHERENT TURN-AROUND CARRIER ● COHERENT TURN-AROUND RANGE CODE

3/1/66

NOTES:

1. THE MINIMUM WORD INTELLIGIBILITY SHALL BE 90% FOR NORMAL VOICE [illegible]CATIONS AND 70% FOR BACK-UP [illegible] AS MEASURED BY USER PER[illegible]LATED OPERATING CONDITIONS [illegible] THE AMERICAN STANDARD METHOD FOR [illegible]EMENT OF MONOSYLLABIC WORD INTELLIGIBIL[illegible]TY DATED MAY 25, 1960

N/A ON 202

2. THE TELEMETRY SUBSYSTEM SHALL BE DESIGNED TO PROVIDE AN ERROR RATE NOT EXCEEDING ONE BIT IN 10^6 BITS FOR PCM TELEMETRY TRANSMISSIONS TO STATIONS OF THE MSFN AS MEASURED FROM CSM ENCODER TO MSFN DECODER.

3. THE PCM TELEMETRY SUBSYSTEM SHALL BE CAPABLE OF TRANSMITTING THE PCM BIT STREAM REQUIRED FOR REAL-TIME USE VIA COAXIAL CABLE TO THE CHECKOUT FACILITY IN THE MILA PRIOR TO LIFT-OFF AND VIA AN RF LINK PRIOR TO AND AFTER LIFT-OFF.

4. THE UP-DATA SUBSYSTEM SHALL BE DESIGNED IN CONJUNCTION WITH STATIONS OF THE MSFN SUCH THAT NO MORE THAN ONE CORRECT MESSAGE SHALL BE REJECTED PER 1000 CORRECT MESSAGES AND THAT NO MORE THAN ONE PER 10^9 INCORRECT MESSAGES SHALL BE ACCEPTED.

LEGEND

EQUIPMENT/FUNCTION THIS FLIGHT	EQUIPMENT/FUNCTION LUNAR MISSION	CODING
REQUIRED	REQUIRED	
REQUIRED	NOT REQUIRED	
NOT REQUIRED	REQUIRED	
NOT REQUIRED	NOT REQUIRED	

APPENDIX 202
TABLE 3.7-1
REQUIRED CSM COVERAGE
APOLLO-SATURN 202

SUBSYSTEM / PHASE	S-IB BURN	S-IVB BURN	END OF S-IVB BURN +3 MINUTES	COAST	-2 MINUTES TO SPS BURN INITIATION	SPS BURNS	CM SEPARATION	CM ENTRY
VHF								
SIMULATED VOICE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	PARTIAL COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	PARTIAL COVERAGE
TELEMETRY	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	PARTIAL COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	PARTIAL COVERAGE
UHF								
UP-DATA	PARTIAL COVERAGE	PARTIAL COVERAGE	CONTINUOUS COVERAGE	PARTIAL COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	PARTIAL COVERAGE
C-BAND								
TRACKING	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	PARTIAL COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	PARTIAL COVERAGE
S-BAND								
SIMULATED VOICE	S-BAND COVERAGE SHALL BE PROVIDED FROM OPERABLE MSFN SITES, WHEN THE TRAJECTORY PERMITS.							
TELEMETRY								
UP-DATA								
TRACKING								

PARTIAL COVERAGE

CONTINUOUS COVERAGE

NOT REQUIRED

3/1/66

TABLE 3.7-1
APOLLO-SATURN 202

APPENDIX 202
TABLE 3. 7-4
REQUIRED SATURN IB LAUNCH VEHICLE COVERAGE
APOLLO - SATURN 202

SUBSYSTEM \ PHASE	S-IB BURN	S-IVB BURN	END OF S-IVB BURN +3 MINUTES	COAST
VHF TELEMETRY				
S-IB	CONTINUOUS COVERAGE [1]			
S-IVB	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	PARTIAL COVERAGE
IU	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	PARTIAL COVERAGE
COMMAND DESTRUCT				
S-IB	CONTINUOUS COVERAGE [2]			
S-IVB	CONTINUOUS COVERAGE	PARTIAL COVERAGE [2]		
TRACKING				
C-BAND	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE [3]	CONTINUOUS COVERAGE	PARTIAL COVERAGE
ODOP	PARTIAL COVERAGE [3]			
AZUSA	PARTIAL COVERAGE	PARTIAL COVERAGE [3]		
TELEVISION				
UHF	PARTIAL COVERAGE	PARTIAL COVERAGE	PARTIAL COVERAGE [4]	

3/1/66

1 COVERAGE SHALL CONTINUE FOR AT LEAST ONE MINUTE AFTER THE END OF BURN.

2 CONTINUOUS COVERAGE UNTIL THE PREDICTED IMPACT POINT OF THE VEHICLE IS OUTSIDE AREAS SPECIFIED BY RANGE SAFETY.

3 TWO LAUNCH VEHICLE TRANSPONDERS SHALL BE TRACKED CONTINUOUSLY TO SATISFY RANGE SAFETY REQUIREMENTS.

4 CONTINUOUS COVERAGE IS REQUIRED DURING DEPLOYMENT OF THE ADAPTER PANELS.

PARTIAL COVERAGE

CONTINUOUS COVERAGE

NOT REQUIRED

TABLE 3. 7-4
APOLLO - SATURN 202

Apollo Saturn Mission 203

1.0 Scope This appendix to the Apollo Program Specification identifies the performance, design and test requirements which apply to the Program elements to be utilized for Apollo Saturn Mission 203 (AS-203). These requirements are presented in this appendix as deviations to the requirements specified for equipment for the lunar landing mission and the operational version of the Saturn IB launch vehicle and facilities. Unless otherwise noted, the paragraphs in this appendix replace in their entirety the identically numbered paragraphs in the body of the specification.

1.1 Applicability No change.[1]

1.2 Change Approval No change.

2.0 Applicable Documents No change.

3.0 Requirements

3.1 Performance

3.1.1 Characteristics

3.1.1.1 General Add: To the extent practicable, the hardware used on AS-203 shall be of the same design as the operational version except as specified otherwise herein.

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(1) The phrase "no change" is used after a section heading throughout this appendix to mean that the requirement in the body of the specification applies to this mission without change.

Apollo Saturn Mission 203

3.1.1.2 Mission Performance

3.1.1.2.1 Mission Mode A shroud shall be used to replace the Apollo spacecraft which is not required for this mission. A Saturn IB launch vehicle consisting of an S-IB first stage, S-IVB second stage and Instrument Unit, shall be used and shall be launched from the Cape Kennedy launch area (LC 37B). The S-IVB second stage shall be placed into an Earth orbit where a liquid hydrogen (LH_2) experiment shall be performed. No recovery of flight hardware is required.

3.1.1.2.2 Mission Command Command and decision making shall be exercised by Earth-based personnel. The Manned Space Flight Network (MSFN) shall be used for communication with, and for tracking of, the launch vehicle.

3.1.1.2.3 Payload The payload for this mission shall include LH_2 remaining in the S-IVB stage after powered flight and will be used in the performance of the hydrogen experiment. The primary objectives of this mission shall include those identified in Apollo Flight Mission Assignments, M-D MA 500-11.

3.1.1.2.4 Earth Launch Launch capability shall be provided to permit an initial flight azimuth of 072°.

3.1.1.2.5 Earth Parking Orbit The capability shall be provided to perform the mission using a near-circular Earth parking orbit with a nominal altitude of 100 nm.

3.1.1.2.6 Injection Opportunities Not Applicable. (N/A).[2]

3.1.1.2.7 Lunar Landing Accuracy N/A.

(2) The phrase "not applicable" is used after a section heading throughout this appendix to mean that the requirement in the body of the specification does not apply to this mission.

Apollo Saturn Mission 203

3.1.1.2.8 Lunar Exploration N/A.

3.1.1.2.9 Earth Landing N/A.

3.1.1.2.10 Recovery N/A.

3.1.2 Program Definition No change.

3.1.3 Operability

3.1.3.1 Logistics No change.

3.1.3.2 Safety No change.

3.1.3.3 Reliability The numerical reliability values for mission success given in Table 3.1-2 shall be used where applicable for engineering design and as a standard for evaluating test results. The probability of mission success for the S-IB stage shall be at least 0.95.

On Table 3.1-2 change Note 1 to: The preflight phase begins with the decision to start the countdown for launch and ends with launch. Change Note 2 to: The flight phase begins with space vehicle liftoff from the launch pad and terminates with conclusion of the LH_2 experiment.

3.2 Program Standards No change.

3.3 Saturn IB Launch Vehicle

3.3.1 General No change except that the S-IVB (Saturn IB version) shall be modified where necessary to be similar to the S-IVB

Apollo Saturn Mission 203

(Saturn V version) to accomplish the mission objectives of 3.1.1.2.3 (203), and the launch vehicle control weights shall be as specified for AS-203 in Table 10.1-1, Appendix 10.1.

3.3.1.1 Payload The launch vehicle shall have the payload capability specified for AS-203 in Table 10.1-1, Appendix 10.1.

3.3.1.2 Standby Time No change.

3.3.1.3 Prelaunch Checkout No change.

3.3.1.4 In-Flight Performance Evaluation No change.

3.3.1.5 Emergency Detection Subsystem No change except that EDS information shall not be provided for display to the crew, and the EDS shall be operated in an open-loop mode.

3.3.1.6 Instrumentation An instrumentation subsystem shall be provided in the launch vehicle to permit ground personnel to evaluate launch vehicle performance. Special instrumentation, including TV, required for the LH_2 experiment shall be provided.

3.3.1.7 Command Destruct No change.

3.3.1.8 Electrical Power No change.

3.3.2 Structure No change.

3.3.3 Propulsion No change except:

The H-1 engine thrust shall be 200,000 ± 6,000 pounds.

The J-2 engine shall provide a nominal vacuum specific impulse of 422 seconds and a minimum vacuum specific impulse of 418 seconds.

3.3.4 Launch Vehicle Guidance, Navigation and Control

3.3.4.1 General The launch vehicle guidance, navigation and control system shall provide the guidance, navigation and control functions which are required for the space vehicle from liftoff through the completion of S-IVB Earth orbit operations. The principal elements shall be an inertial measurement unit (IMU), a digital computer and control electronics. These elements shall be located in the IU.

3.3.4.1.1 No change.

3.3.4.1.2 N/A.

3.3.5 Saturn IB Launch Vehicle Communications and Tracking

3.3.5.1 General The Communication and Tracking System of the Saturn IB launch vehicle shall have the following capabilities:

(a) Telemetry transmission.
(b) Tracking aid.
(c) Up-data reception.
(d) Command-destruct data reception.
(e) Television transmission.

3.3.5.2 Functional Capability Add the following paragraph.

3.3.5.2.5 Television The television subsystem in the IU (the camera assembly is located in the S-IVB) shall be able to provide television transmission to stations of the MSFN for at least 4.5 hours after launch.

3.3.5.3 Coverage Capability The Saturn IB Communication and Tracking System shall be able to operate with the MSFN to achieve the coverage specified in Table 3.7-4 (203) of this appendix.

3.3.5.4 Performance The Saturn IB Communication and Tracking System shall meet the requirements specified in Table 3.3-1 (203) of this appendix.

Apollo Saturn Mission 203

3.4 Saturn V Launch Vehicle N/A.

3.5 Spacecraft N/A Refer to 3.1.1.2.1 (203).

3.6 Launch Area

3.6.1 General

3.6.1.1 No change.

3.6.1.2 No change except that requirements for the Operations and Checkout Building and associated facilities are not applicable.

3.6.1.3 No change.

3.6.1.4 No change.

3.6.2 Space Vehicle Checkout Systems LC 37B shall utilize launch vehicle checkout equipment capable of effecting automated checkout of a Saturn IB launch vehicle. As far as possible, the checkout equipment for the Saturn IB space vehicle shall be identical to that to be used for the Apollo Saturn V. In addition, the launch vehicle checkout systems shall:

(a) through (g) - No change.

3.6.3 Launch Complex 37B LC 37B shall include three major items: the launch pad and umbilical tower, the service structure and the Launch Control Center.

LC 37B shall provide the capability for on-pad assembly, preparation and launch of an unmanned LH_2 experiment on a Saturn IB launch vehicle. The capability shall be provided to continue those services and operations necessary to support a launch hold of up to 12 hours occurring after completion of propellant loading.

LC 37B shall be designed to permit the launching of an Apollo Saturn IB during the 95 percentile peak surface wind conditions given in 2.3.2.3 of M-DE 8020.008B.

3.6.3.1 Launch Pad and Umbilical Tower No changes except as follows:

(a) Delete reference to the Operations and Checkout Building.

(c) N/A

3.6.3.2 Service Structure No change.

3.6.3.3 Launch Control Center No change except as follows:

(c) N/A.

(e) N/A.

3.6.4 Launch Complex 39 N/A.

3.6.5 Direct Launch Support Facilities

3.6.5.1 Operations and Checkout Building N/A.

3.6.5.2 Central Instrumentation Facility No change except that references to the Operations and Checkout Building are not applicable.

3.6.5.3 Central Telephone Office No change except that references to the Operations and Checkout Building are not applicable.

3.7 Manned Space Flight Network

3.7.1 General No change.

Apollo Saturn Mission 203

3.7.2 Functional Capability

3.7.2.1 Voice Communications The voice communications subsystem shall enable duplex, 4-wire communications between MSFN stations and MCC.

3.7.2.2 Telemetry The telemetry subsystem shall be able to receive:

(a) Operational telemetry from each stage of the launch vehicle and the IU.

(b) Engineering data from the space vehicle.

3.7.2.3 Tracking No change except:

(a) N/A.

(e) N/A.

3.7.2.4 Digital Command Communications No change except that the CSM references are not applicable.

3.7.2.5 Television The television subsystem shall be able to receive, record and display television transmission from the IU locally at the Cape Kennedy, Bermuda, Carnarvon and Corpus Christi sites.

3.7.2.6 Display and Control No change except that the LEM and CSM references are not applicable.

3.7.2.7 Data Processing No change.

3.7.2.8 Timing No change.

3.7.3 Coverage Capability The MSFN station in the launch area shall be able to support the prelaunch checkout of the space vehicle on the launch pad.

The MSFN shall provide the coverage capabilities for the space vehicle as specified in Table 3.7-4 (203) of this appendix.

Apollo Saturn Mission 203

3.7.4 Performance No change except that the MSFN shall operate with the space vehicle subsystems as specified in 3.3.5 of this appendix.

3.8 Mission Control Center No change except delete 3.8.1 (d).

4.0 Quality Assurance No change.

APPENDIX 203

TABLE 3.3 - 1

SATURN IB LAUNCH VEHICLE COMMUNICATION AND TRACKING REQUIREMENTS

APOLLO-SATURN 203

STAGE / SUBSYSTEM	EQUIPMENT IMPLEMENTATION	NUMBER OF UNITS	OPERATING FREQUENCY		ANTENNA SUBSYSTEM	MODULATION CHARACTERISTICS	REMARKS
			TRANSMIT	RECEIVE			
S-IB TELEMETRY	PCM/FM TELEMETER	ONE	225-260 Mc		OMNI-DIRECTIONAL	PCM/FM	• SEE NOTES 1, 2 AND 3 • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND
	FM/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF S-IB PCM/FM TELEMETER	FM/FM	• SEE NOTES 1 AND 4 • PAM/FM/FM MODULATION UTILIZED DURING R & D FLIGHT PROGRAM
	PAM/FM/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF S-IB PCM/FM TELEMETER	PAM/FM/FM	• SEE NOTES 1 AND 4
	SS/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF S-IB PCM/FM TELEMETER	SS/FM	• SEE NOTE 4
COMMAND DESTRUCT	RECEIVER AND DECODER	TWO		400-450 Mc	OMNI-DIRECTIONAL		• THIS SYSTEM SHALL BE COMPATIBLE WITH RANGE SAFETY COMMAND TRANSMITTERS INSTALLED AT STATIONS OF THE ETR.
TRACKING	ODOP TRANSPONDER	ONE	UHF	UHF	FIXED DIRECTIONAL		
S-IVB TELEMETRY	PCM/FM TELEMETER	ONE	225-260 Mc		OMNI-DIRECTIONAL	PCM/FM	• SEE NOTES 1, 2 AND 3 • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND
	FM/FM TELEMETER 6	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF S-IVB PCM/FM TELEMETER	FM/FM	• SEE NOTES 1 AND 4 • PAM/FM/FM MODULATION UTILIZED DURING R & D FLIGHT PROGRAM
	PAM/FM/FM TELEMETER	TWO	225-260 Mc		SEE NOTE 5	PAM/FM/FM	• SEE NOTES 1 AND 4
	SS/FM TELEMETER	ONE	225-260 Mc		SEE NOTE 5	SS/FM	• SEE NOTE 4
COMMAND DESTRUCT	RECEIVER AND DECODER	TWO		400-450 Mc	OMNI-DIRECTIONAL		• THIS SYSTEM SHALL BE COMPATIBLE WITH RANGE SAFETY COMMAND TRANSMITTERS INSTALLED AT STATIONS OF THE ETR.
INSTRUMENT UNIT TELEMETRY	PCM/FM TELEMETER	ONE	225-260 Mc		OMNI-DIRECTIONAL	PCM/FM	• SEE NOTES 1, 2 AND 3 • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND • BIT STREAM SHALL CONTAIN ALL S-IVB/IU MISSION CONTROL DATA
	PCM/FM TELEMETER	ONE	2100-2300 Mc			PCM/FM	• SEE NOTES 1, 2 AND 3 • EXPERIMENTAL SYSTEM • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND • BIT STREAM SHALL BE IDENTICAL WITH IU VHF PCM/FM TELEMETER
	FM/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF IU VHF PCM/FM TELEMETER	FM/FM	• SEE NOTES 1 AND 4
	PAM/FM/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF IU VHF PCM/FM TELEMETER	PAM/FM/FM	• SEE NOTES 1 AND 4
	SS/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF IU VHF PCM/FM TELEMETER	SS/FM	• SEE NOTE 4
UP-DATA	RECEIVER AND DECODER	ONE		400-450 Mc	OMNI-DIRECTIONAL	PSK/FM	• SUBCODED 5-BIT WORDS AT 1000 BITS/SECOND • THE UP-DATA SUBSYSTEM SHALL BE DESIGNED IN CONJUNCTION WITH STATIONS OF THE MSFN SUCH THAT NO MORE THAN ONE CORRECT MESSAGE SHALL BE REJECTED PER 1000 CORRECT MESSAGES AND THAT NO MORE THAN ONE PER 10^9 INCORRECT MESSAGES SHALL BE ACCEPTED.
TRACKING	C-BAND RADAR TRANSPONDER	ONE	C-BAND	C-BAND	OMNI-DIRECTIONAL	PULSE	• UTILIZES CODING DIFFERENT FROM C-BAND RADAR TRANSPONDERS ON SPACECRAFT
	AZUSA TRANSPONDER	ONE	C-BAND	C-BAND	OMNI-DIRECTIONAL	FM	
TELEVISION	TELEVISION TRANSMITTER	ONE	S-BAND				

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NOTES:

1 THIS TELEMETRY SUBSYSTEM SHALL BE COMPATIBLE WITH THE INTER RANGE INSTRUMENTATION GROUP STANDARDS (IRIG DOCUMENT NO. 106-60. "TELEMETRY STANDARDS REVISED 1962")

2. ALL PCM TELEMETRY SUBSYSTEMS SHALL BE DESIGNED TO PROVIDE AN ERROR RATE NOT EXCEEDING ONE BIT IN 10^6 BITS FOR TRANSMISSIONS TO THE MSFN AS MEASURED FROM LAUNCH VEHICLE ENCODER TO EARTH-BASED DECODER.

3. THIS PCM TELEMETRY SUBSYSTEM SHALL BE CAPABLE OF TRANSMITTING THE PCM BIT STREAM REQUIRED FOR REAL-TIME USE VIA COAXIAL CABLE TO THE CHECKOUT FACILITY IN THE MILA PRIOR TO LIFT-OFF AND VIA AN RF LINK PRIOR TO AND AFTER LIFT-OFF.

4. THIS TELEMETRY SUBSYSTEM SHALL TRANSMIT DATA REQUIRED ONLY FOR POST-MISSION ANALYSIS VIA AN RF LINK.

5. UP TO 4 VHF STAGE TELEMETERS SHALL BE MULTIPLEXED ON A COMMON ANTENNA SUB-SYSTEM. WHEN MORE THAN 4 VHF STAGE TELEMETERS ARE CARRIED, A SECOND OMNI-DIRECTIONAL ANTENNA SUBSYSTEM SHALL BE PROVIDED.

6. NOT PRESENTLY SCHEDULED FOR OPERATIONAL SATURN IB LAUNCH VEHICLES. HOWEVER, PROVISIONS TO CARRY THIS TELEMETER SHALL BE INCORPORATED ON ALL SATURN IB LAUNCH VEHICLES THROUGH AS-207.

EQUIPMENT/FUNCTION		CODING
THIS FLIGHT	OPERATIONAL VEHICLE	
REQUIRED	REQUIRED	
REQUIRED	NOT REQUIRED	
NOT REQUIRED	REQUIRED	
NOT REQUIRED	NOT REQUIRED	

TABLE 3.3-1
APOLLO SATURN 203

APPENDIX 204/205

TABLE 3.5-2B

CSM UNIFIED S-BAND COMMUNICATIONS AND TRACKING REQUIREMENTS

APOLLO-SATURN 204/205

SUBSYSTEM	EQUIPMENT IMPLEMENTATION	NUMBER OF UNITS	OPERATING FREQUENCY		ANTENNA SUBSYSTEM	MODULATION CHARACTERISTICS	REMARKS
			TRANSMIT	RECEIVE			
VOICE COMMUNICATIONS (SEE NOTE 1) WITH MSFN	PM TRANSPONDER	TWO	S-BAND	S-BAND	OMNI-DIRECTIONAL [illegible]	FM/PM TRANSMIT - 1.25 Mc SUBCARRIER FM/PM RECEIVE 30 Kc SUBCARRIER	● TRANSPONDER FREQUENCY SHALL BE COHERENT WITH SIGNALS RECEIVED FROM THE MSFN AND IN THE RATIO OF 240:221 ● RELAY VOICE AND TELEMETRY COMMUNICATIONS WITH EVA ● BACKUP RELAY OF VOICE COMMUNICATIONS WITH LEM ● TRANSPONDER ALSO PROVIDES FOR TELEMETRY TRANSMISSION, KEYED TRANSMISSION, UP-DATA RECEPTION AND TRACKING ASSISTANCE TO THE MSFN.
						PM TRANSMIT AT BASEBAND	● EMERGENCY VOICE TRANSMISSION ● THIS CAPABILITY IS PROVIDED ONLY WHEN THE CAPABILITY FOR SIMULTANEOUS PM AND FM S-BAND TRANSMISSION IS PROVIDED.
						FM/PM RECEIVE 70 Kc SUBCARRIER	● EMERGENCY VOICE RECEPTION ● THIS CAPABILITY IS PROVIDED ONLY WHEN THE CAPABILITY FOR SIMULTANEOUS PM AND FM S-BAND TRANSMISSION IS PROVIDED ● SEE "UP-DATA FROM MSFN"
WITH MSFN	FM TRANSMITTER #1	ONE	S-BAND		MULTIPLEXED WITH S-BAND TRANSPONDER OMNI-DIRECTIONAL ANTENNA SYSTEM	FM/FM TRANSMIT 1.25 Mc SUBCARRIER	● THIS TRANSMITTER OPERATES ON THE SAME FREQUENCY AS THE TRANSPONDER, THEREFORE IT IS PROVIDED ONLY ON THOSE FLIGHTS FOR WHICH SIMULTANEOUS PM AND FM S-BAND TRANSMISSION IS NOT REQUIRED. ● VOICE RECEPTION IS ACHIEVED VIA PM RECEPTION OF 30 Kc FM SUBCARRIER. ● TRANSMITTER ALSO PROVIDES FOR TELEMETRY, SCIENTIFIC DATA, TELEVISION, AND TAPE PLAYBACK TRANSMISSION TO THE MSFN.
KEYING COMMUNICATIONS TO MSFN	PM TRANSPONDER		S-BAND			AM/PM 512 Kc SUBCARRIER	● SEE "VOICE COMMUNICATIONS WITH MSFN" ● TRANSMITTED ALONE - BACKUP FOR VOICE TRANSMISSION
TELEMETRY TO MSFN	PM TRANSPONDER		S-BAND			PCM/PM/PM 1.024 Mc SUBCARRIER NRZ-C SERIAL BIT STREAM	● SEE "VOICE COMMUNICATIONS WITH MSFN" ● SELECTABLE BIT RATES OF 51.2 KILOBITS/SECOND AND 1.6 KILOBITS/SECOND ● SEE NOTES 2 AND 3
						FM/FM/PM 7 SUBCARRIERS ON 1.25 Mc VOICE SUBCARRIER	● SEE "VOICE COMMUNICATIONS WITH MSFN" ● RELAY OF COMPOSITE EVA VOICE AND 7 CHANNELS OF EVA TELEMETRY ON VOICE SUBCARRIER WHEN SIMULTANEOUS PM AND FM S-BAND TRANSMISSION CAPABILITY IS PROVIDED.
TO MSFN	FM TRANSMITTER #1		S-BAND			PCM/PM/FM 1.024 Mc SUBCARRIER NRZ-C SERIAL BIT STREAM	● SEE "VOICE COMMUNICATIONS WITH MSFN" ● SELECTABLE BIT RATES OF 51.2 KILOBITS/SECOND AND 1.6 KILOBITS/SECOND ● SEE NOTES 2 AND 3
						FM/FM 95 Kc, 125 Kc, 165 Kc SUBCARRIERS	● SEE "VOICE COMMUNICATIONS WITH MSFN" ● PROVIDES 3 CHANNELS OF REAL TIME SCIENTIFIC DATA TRANSMISSION TO THE MSFN ● SIX ADDITIONAL SUBCARRIERS ARE ALSO AVAILABLE
TO MSFN	FM TRANSMITTER #2	ONE	S-BAND		MULTIPLEXED WITH S-BAND TRANSPONDER ANTENNA SYSTEM	FM/FM 95 Kc, 125 Kc, 165 Kc SUBCARRIERS	● THIS TRANSMITTER IS PROVIDED ONLY ON THOSE FLIGHTS FOR WHICH SIMULTANEOUS PM AND FM S-BAND TRANSMISSION IS REQUIRED. ● TRANSMITTER ALSO PROVIDES FOR TELEVISION AND TAPE PLAYBACK TRANSMISSION TO THE MSFN. ● PROVIDES 3 CHANNELS OF REAL TIME SCIENTIFIC DATA TRANSMISSION TO THE MSFN
TAPE PLAYBACK TO MSFN	FM TRANSMITTER #1		S-BAND				● SEE "VOICE COMMUNICATIONS WITH MSFN"
						FM/FM 95 Kc, 125 Kc, 165 Kc SUBCARRIERS	● RECORDED SCIENTIFIC DATA - 3 CHANNELS ● SIX ADDITIONAL CHANNELS ARE ALSO AVAILABLE
						FM/FM ANALOG SUBCARRIER	● RECORDED VOICE
						PCM/PM/FM 1.024 Mc SUBCARRIER	● RECORDED CSM PCM TELEMETRY AT APPARENT 51.2 KILOBITS/SECOND RATE
TO MSFN	FM TRANSMITTER #2		S-BAND				● SEE "TELEMETRY TO MSFN"
						FM/FM 95 Kc, 125 Kc, 165 Kc SUBCARRIERS	● RECORDED SCIENTIFIC DATA - 3 CHANNELS
						FM AT BASEBAND	● RECORDED VOICE
						PCM/PM/FM 1.024 Mc SUBCARRIER	● RECORDED CSM PCM TELEMETRY AT APPARENT 51.2 KILOBITS/SECOND
						FM AT BASEBAND	● RECORDED LEM 1.6 KILOBITS /SECOND PCM TELEMETRY AT APPARENT 51.2 KILOBITS/SECOND
TELEVISION TO MSFN	FM TRANSMITTER #1		S-BAND			FM AT BASEBAND	● SEE "VOICE COMMUNICATIONS WITH MSFN"
TO MSFN	FM TRANSMITTER #2		S-BAND			FM AT BASEBAND	● SEE "TELEMETRY TO MSFN"
UP-DATA (SEE NOTE 4) FROM MSFN	PM TRANSPONDER			S-BAND		PSK/FM/PM 70 Kc SUBCARRIER	● SEE "VOICE COMMUNICATIONS WITH MSFN" ● SUBCODED 5-BIT WORDS AT 1000 BITS/SECOND
TRACKING AID TO MSFN	PM TRANSPONDER		S-BAND	S-BAND		PM RECEIVE- PRN CODE AT BASEBAND PM TRANSMIT- PRN CODE AT BASEBAND	● SEE "VOICE COMMUNICATIONS WITH MSFN" ● COHERENT TURN-AROUND CARRIER ● COHERENT TURN-AROUND RANGE CODE

3/1/66

NOTES:

1. THE MINIMUM WORD INTELLIGIBILITY SHALL BE 90% FOR NORMAL VOICE COMMUNICATIONS AND 70% FOR BACK-UP COMMUNICATIONS AS MEASURED BY USER PERSONNEL UNDER SIMULATED OPERATING CONDITIONS UTILIZING THE AMERICAN STANDARD METHOD FOR MEASUREMENT OF MONOSYLLABIC WORD INTELLIGIBILITY DATED MAY 25, 1960

2. THE TELEMETRY SUBSYSTEM SHALL BE DESIGNED TO PROVIDE AN ERROR RATE NOT EXCEEDING ONE BIT IN 10^6 BITS FOR PCM TELEMETRY TRANSMISSIONS TO STATIONS OF THE MSFN AS MEASURED FROM CSM ENCODER TO MSFN DECODER.

3. THE PCM TELEMETRY SUBSYSTEM SHALL BE CAPABLE OF TRANSMITTING THE PCM BIT STREAM REQUIRED FOR REAL-TIME USE VIA COAXIAL CABLE TO THE CHECKOUT FACILITY IN THE MILA PRIOR TO LIFT-OFF AND VIA AN RF LINK PRIOR TO AND AFTER LIFT-OFF.

4. THE UP-DATA SUBSYSTEM SHALL BE DESIGNED IN CONJUNCTION WITH STATIONS OF THE MSFN SUCH THAT NO MORE THAN ONE CORRECT MESSAGE SHALL BE REJECTED PER 1000 CORRECT MESSAGES AND THAT NO MORE THAN ONE PER 10^9 INCORRECT MESSAGES SHALL BE ACCEPTED.

LEGEND

EQUIPMENT/FUNCTION		CODING
THIS FLIGHT	LUNAR MISSION	
REQUIRED	REQUIRED	
REQUIRED	NOT REQUIRED	
NOT REQUIRED	REQUIRED	
NOT REQUIRED	NOT REQUIRED	

APPENDIX 203
TABLE 3, 7-4
REQUIRED SATURN IB LAUNCH VEHICLE COVERAGE
APOLLO - SATURN 203

SUBSYSTEM \ PHASE	S-IB BURN	S-IVB BURN	END OF S-IVB BURN +3 MINUTES	COAST IN EARTH ORBIT [4]	S-IV B/IU CHECKOUT IN EARTH ORBIT [5]
VHF TELEMETRY					
S-IB	1				
S-IVB					
IU					
TELEMETRY [6]					
IU					
TELEVISION					
IU					
COMMAND DESTRUCT					
S-IB	2				
S-IVB		2			
UHF UP-DATA					
IU					
TRACKING					
C-BAND		3			
ODOP	3				
AZUSA		3			

3/1/66

1. COVERAGE SHALL CONTINUE FOR AT LEAST ONE MINUTE AFTER THE END OF BURN.
2. CONTINUOUS COVERAGE UNTIL THE PREDICTED IMPACT POINT OF THE VEHICLE IS OUTSIDE AREAS SPECIFIED BY RANGE SAFETY.
3. TWO LAUNCH VEHICLE TRANSPONDERS SHALL BE TRACKED CONTINUOUSLY TO SATISFY RANGE SAFETY REQUIREMENTS.
4. THE GAP BETWEEN CONTACTS SHALL BE NO GREATER THAN 1/2 ORBIT. CONTACTS SHALL BE AT LEAST 3 MINUTES LONG.
5. THIS REQUIREMENT MAY BE SATISFIED DURING AN ORBITAL CONTACT.
6. EXPERIMENTAL SYSTEM.

PARTIAL COVERAGE
CONTINUOUS COVERAGE
NOT REQUIRED

APPENDIX 204/205

TABLE 3.7-4

REQUIRED SATURN IB LAUNCH VEHICLE COVERAGE

APOLLO-SATURN 204/205

SUBSYSTEM \ PHASE	S-IB BURN	S-IVB BURN	END OF S-IVB BURN +3 MINUTES	COAST IN EARTH ORBIT [4]	S-IVB/IU CHECKOUT IN EARTH ORBIT [5]	SPACECRAFT SEPARATION [5]
VHF TELEMETRY						
S-IB	CONTINUOUS [1]					
S-IVB	CONTINUOUS	CONTINUOUS	CONTINUOUS	PARTIAL	CONTINUOUS	CONTINUOUS
IU	CONTINUOUS	CONTINUOUS	CONTINUOUS	PARTIAL	CONTINUOUS	CONTINUOUS
TELEMETRY [6]						
IU	PARTIAL	PARTIAL	PARTIAL	PARTIAL	CONTINUOUS	CONTINUOUS
COMMAND DESTRUCT						
S-IB	CONTINUOUS [2]					
S-IVB	CONTINUOUS	PARTIAL [2]				
UHF UP-DATA						
IU	PARTIAL	PARTIAL	CONTINUOUS	PARTIAL	CONTINUOUS	CONTINUOUS
TRACKING						
C-BAND	CONTINUOUS	CONTINUOUS [3]	CONTINUOUS	PARTIAL	CONTINUOUS	CONTINUOUS
ODOP	PARTIAL [3]					
AZUSA	PARTIAL	PARTIAL [3]				

3/1/66

1 COVERAGE SHALL CONTINUE FOR AT LEAST ONE MINUTE AFTER THE END OF BURN.

2 CONTINUOUS COVERAGE UNTIL THE PREDICTED IMPACT POINT OF THE VEHICLE IS OUTSIDE AREAS SPECIFIED BY RANGE SAFETY.

3 TWO LAUNCH VEHICLE TRANSPONDERS SHALL BE TRACKED CONTINUOUSLY TO SATISFY RANGE SAFETY REQUIREMENTS.

4 THE GAP BETWEEN CONTACTS SHALL BE NO GREATER THAN 1/2 ORBIT. CONTACTS SHALL BE AT LEAST 3 MINUTES LONG.

5 THIS REQUIREMENT MAY BE SATISFIED DURING AN ORBITAL CONTACT.

6 EXPERIMENTAL SYSTEM - NOT REQUIRED ON AS-205.

PARTIAL COVERAGE

CONTINUOUS COVERAGE

NOT REQUIRED

TABLE 3.7-4
APOLLO-SATURN 204/205

Apollo Saturn Missions 204 and 205

1.0 Scope This appendix to the Apollo Program Specification identifies the performance, design and test requirements which apply to the Program elements to be utilized for Apollo Saturn Missions 204 and 205 (AS-204 and AS-205). These requirements are presented in this appendix as deviations to the requirements specified for equipment for the lunar landing mission and the operational version of the Saturn IB launch vehicle and facilities. Unless otherwise noted, the paragraphs in this appendix replace in their entirety the identically numbered paragraphs in the body of the specification.

1.1 Applicability No change.[1]

1.2 Change Approval No change.

2.0 Applicable Documents No change.

3.0 Requirements

3.1 Performance

3.1.1 Characteristics

3.1.1.1 General Add: To the extent practicable, the hardware used on AS-204 and AS-205 shall be of the same design as the operational version.

(1) The phrase "no change" is used after a section heading throughout this appendix to mean that the requirement in the body of the specification applies to this mission without change.

Apollo Saturn Missions 204 and 205

3.1.1.2 Mission Performance

3.1.1.2.1 Mission Mode This Apollo test mission shall be an Earth orbital mission. The spacecraft, which includes a manned CM and an SM, shall be launched from the Cape Kennedy launch area (LC 34) into the desired trajectory by a Saturn IB launch vehicle consisting of an S-IB first stage, an S-IVB (Saturn IB version) second stage and an IU. After CSM separation from the launch vehicle and Spacecraft Adapter, the spacecraft propulsion system shall be used to maneuver in Earth orbit, including CSM maneuvers with the rest of the space vehicle as a target. After Earth parking orbit operations, the spacecraft propulsion system is to be used to reduce the spacecraft velocity sufficiently for entry. The CM shall be slowed to a safe landing by aerodynamic braking after separation from the SM, and during the final phases of the landing sequence by parachute.

3.1.1.2.2 Mission Command No change.

3.1.1.2.3 Payload The payload for this mission shall include an SM and a manned CM. The primary objectives of this mission shall include those identified in Apollo Flight Mission Assignments, M-D MA 500-11.

3.1.1.2.4 Earth Launch Launch capability shall be provided to permit an initial flight azimuth of 072°.

3.1.1.2.5 Earth Parking Orbit The capability shall be provided to perform the mission using an elliptical Earth parking orbit with a nominal apogee of 130 nm and a nominal perigee of 85 nm.

3.1.1.2.6 Injection Opportunities Not applicable. (N/A).[2]

(2) The phrase "not applicable" is used after a section heading throughout this appendix to mean that the requirement in the body of the specification does not apply to this mission.

Apollo Saturn Missions 204 and 205

3.1.1.2.7 Lunar Landing Accuracy N/A.

3.1.1.2.8 Lunar Exploration N/A.

3.1.1.2.9 Earth Landing The normal Earth landing mode shall be on water. The capability for water and land landing shall be as specified in 3.5.1.24.

3.1.1.2.10 Recovery No change

3.1.2 Program Definition No change.

3.1.3 Operability

3.1.3.1 Logistics No change.

3.1.3.2 Safety No change.

3.1.3.3 Reliability

3.1.3.3.1 Equipment Reliability No change except: In Table 3.1-2 add "the success probability for the S-IB stage shall be at least 0.95." Change Note 1 to "the preflight phase begins with the decision to start countdown for launch and ends with launch".

3.1.3.3.2 Environmental Hazards Change "the lunar landing mission" to "this mission" and delete reference to the lunar surface.

3.1.3.3.3 Crew Safety No change.

3.1.3.3.4 System Design Policy No change.

3.1.3.3.5 Reliability Assurance No change.

3.2 Program Standards No change.

3.3 Saturn IB Launch Vehicle

Apollo Saturn Missions 204 and 205

3.3.1 General No change except that the launch vehicle control weights shall be as specified for AS-204 and for AS-205 in Table 10.1-1, Appendix 10.1.

3.3.1.1 Payload The launch vehicle shall provide the payload capability specified for AS-204 and for AS-205 in Table 10.1-1, Appendix 10.1.

3.3.1.2 Standby Time No change.

3.3.1.3 Prelaunch Checkout No change.

3.3.1.4 In-Flight Performance Evaluation No change.

3.3.1.5 Emergency Detection Subsystem No change.

3.3.1.6 Instrumentation No change.

3.3.1.7 Command Destruct No change.

3.3.1.8 Electrical Power No change.

3.3.2 Structure No change.

3.3.2.1 Prelaunch Environment No change.

3.3.2.2 Launch and Flight Environment The launch vehicle shall be capable of being launched in the 90 percentile peak surface wind conditions given in 2.3.2.3 of M-DE 8020.008B and associated wind shears given in 2.3.2.4 of M-DE 8020.008B. The launch vehicle shall be capable of flight in the 95 percentile quasi-steady state in-flight winds given in 2.3.2.5 of M-DE 8020.008B. In addition, the vehicle shall be capable of flight with 85 percent of the 99 percentile wind shears given in 2.3.2.6 of M-DE 8020.008B, and with 85 percent of the quasi-square wave gust given in 2.3.2.8 of M-DE 8020.008B, both superimposed on the 95 percentile quasi-steady state in-flight winds given in 2.3.2.5 of M-DE 8020.008B.

Apollo Saturn Missions 204 and 205

3.3.3 Propulsion No change except that H-1 engine thrust shall be 200,000 ± 6,000 pounds.

3.3.4 Launch Vehicle Guidance, Navigation and Control

3.3.4.1 General The launch vehicle guidance, navigation and control system shall provide the guidance, navigation and control functions which are required for the space vehicle from liftoff through the completion of CSM maneuvers with the rest of the space vehicle. This includes a simulated docking on AS-205. The principal elements shall be an inertial measurement unit (IMU), a digital computer and control electronics. These elements shall be located in the IU.

3.3.4.1.1 No change.

3.3.4.1.2 N/A.

3.3.5 Saturn IB Launch Vehicle Communications and Tracking

3.3.5.1 General No change.

3.3.5.2 Functional Capability No change.

3.3.5.3 Coverage Capability The Saturn IB Communication and Tracking Systems for Apollo flight missions 204 and 205 shall be able to operate with the MSFN to achieve the coverage specified in Table 3.7-4 (204/205) of this appendix.

3.3.5.4 Performance The Saturn IB Communication and Tracking Systems for Apollo flight mission 204 shall meet the requirements specified in Table 3.3-1 (204) of this appendix. The Saturn IB Communication and Tracking System for Apollo flight mission 205 shall meet the requirements specified in Table 3.3-1 located in the body of this specification.

Apollo Saturn Missions 204 and 205

3.4 Saturn V Launch Vehicle N/A.

3.5 Spacecraft

3.5.1 General No change except:

The spacecraft shall be designed to be mated to a Saturn IB launch vehicle.

Spacecraft control weights shall be as specified for AS-204 and AS-205 in Table 10.1-3, Appendix 10.1.

Delete references to the LEM and the ΔV budget.

3.5.1.1 Prelaunch Environment No change.

3.5.1.2 Prelaunch Checkout No change.

3.5.1.3 In-Flight Performance Evaluation No change.

3.5.1.4 Standby Time The spacecraft shall have the capability to stand by in a loaded condition, after launch vehicle propellant loading, for 10 hours and still perform the mission.

3.5.1.5 Launch and Flight Environment The spacecraft shall be capable of being launched in the 90 percentile peak surface wind conditions given in 2.3.2.3 of M-DE 8020.008B and associated wind shears given in 2.3.2.4 of M-DE 8020.008B. The spacecraft shall be capable of flight in the 95 percentile quasi-steady state in-flight winds given in 2.3.2.5 of M-DE 8020.008B. In addition, the spacecraft shall be capable of flight with 85 percent of the 99 percentile wind shears given in 2.3.2.6 of M-DE 8020.008B, and with 85 percent of the quasi-square wave gust given in 2.3.2.8 of M-DE 8020.008B, both superimposed on the 95 percentile quasi-steady state in-flight winds given in 2.3.2.5 of M-DE 8020.008B.

Apollo Saturn Missions 204 and 205

3.5.1.6 Earth Orbit Environment No change.

3.5.1.7 Translunar Environment N/A.

3.5.1.8 Transposition After separation the CSM shall be capable of performing maneuvers with the rest of the space vehicle as a target. The spacecraft shall be capable of avoiding impact with the rest of the space vehicle during subsequent flight maneuvers.

3.5.1.9 One-Man Operation The spacecraft shall be designed so that a single crew member can perform all functions required to accomplish a safe return to Earth from any point in the mission.

3.5.1.10 CSM/LEM Abort N/A.

3.5.1.11 Separation Time N/A.

3.5.1.12 Descent Abort N/A.

3.5.1.13 Translational Range N/A.

3.5.1.14 Lunar Environment N/A.

3.5.1.15 Lunar Landing N/A.

3.5.1.16 Lunar Operations N/A.

3.5.1.17 Scientific Equipment Support See 3.5.7 (AS-204/205).

3.5.1.18 Sterilization No change.

3.5.1.19 Launch Platform N/A.

3.5.1.20 Ascent Stage Operations N/A.

3.5.1.21 Rendezvous and Dock N/A.

3.5.1.22 Entry The CM shall be capable of controlled flight through the Earth's atmosphere (as given in 2.5 of M-DE 8020.008B) to a preselected water landing area. This shall be possible without exceeding a 10g deceleration for an Earth orbital entry. The design limit entry load for all CM systems shall be a 20g deceleration.

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Apollo Saturn Missions 204 and 205

3.5.1.23 Aerodynamic Characteristics No change.

3.5.1.24 Landing No change.

3.5.1.25 Postlanding No change.

3.5.1.26 Recovery No change.

3.5.2 Command and Service Modules

3.5.2.1 Structure

3.5.2.1.1 Cabin Space No change.

3.5.2.1.2 Windows No change.

3.5.2.1.3 Ingress and Egress No change except delete (a) and (b).

3.5.2.1.4 Docking N/A.

3.5.2.1.5 Thermal Requirements No change.

3.5.2.1.6 Extravehicular Mobility Unit (EMU) Storage No change.

3.5.2.2 CSM Propulsion

3.5.2.2.1 General Thrust, specific impulse, minimum impulse and propellants for CSM propulsion subsystems shall be as specified in Table 3.5-1 except that SPS thrust shall be 21,500 ± 215 pounds, SPS nominal vacuum specific impulse shall be 311.2 seconds and SPS minimum vacuum specific impulse shall be 307.6 seconds. The service life of propulsion subsystems after pre-mission testing shall allow the engines to be fired for sufficient time to deplete propellants available when all propellant tanks are loaded to the maximum capacity.

3.5.2.2.2 Command Module Reaction Control Subsystem No change except delete provisions for dumping unburned propellant.

3.5.2.2.3 Service Module Reaction Control Subsystem No change except delete reference to LEM.

3.5.2.2.4 Service Module Propulsion Subsystem No change except delete reference to LEM.

Apollo Saturn Missions 204 and 205

3.5.2.3 CSM Communications and Tracking

3.5.2.3.1 General No change.

3.5.2.3.2 Functional Capability No change except: The LEM and EVA references are not applicable. In 3.5.2.3.2.2 add: (g) Transmit the data required for postflight analysis.

3.5.2.3.3 Coverage Capability

3.5.2.3.3.1 CSM-MSFN The CSM Communication and Tracking Systems for Apollo flight missions 204 and 205 shall be able to operate with the MSFN to achieve the coverage specified in Table 3.7-1 (204/205) of this appendix.

3.5.2.3.3.2 CSM-LEM N/A.

3.5.2.3.3.3 CSM-EVA N/A.

3.5.2.3.4 Performance The CSM Communication and Tracking Systems for Apollo flight missions 204 and 205 shall meet the requirements specified in Tables 3.5-2A (204/205) and 3.5-2B (204/205) of this appendix.

3.5.2.4 Electrical Power Subsystem

3.5.2.4.1 General No change except delete reference to LEM.

3.5.2.4.2 Nominal Capacity No change.

3.5.2.4.3 Sizing No change.

3.5.2.4.4 Water and Oxygen Supply No change.

3.5.2.4.5 Pyrotechnic Firing Circuits No change.

3.5.2.4.6 Ground Support No change.

3.5.2.5 Integrated Navigation, Guidance and Control System

3.5.2.5.1 General No change except delete reference to Table 3.5-3.

3.5.2.5.1.1 No change.

3.5.2.5.1.2 No change.

3.5.2.5.1.3 N/A.

Apollo Saturn Missions 204 and 205

3.5.2.5.1.4 No change.

3.5.2.5.1.5 The PNGCS shall:

(a) No change.

(b) No change.

(c) No change.

(d) N/A.

(e) Change "S-IC" to "S-IB" and delete "S-II."

(f) No change.

3.5.2.5.2 Accuracy The navigation, guidance and control system shall be capable of guiding the CM during entry to the selected point of parachute deployment within a 10 nm CEP.

3.5.2.6 Display and Control Subsystem No change except delete 3.5.2.6.6.

3.5.2.7 Environmental Control Subsystem No change.

3.5.2.8 Crew Equipment No change.

3.5.3 Lunar Excursion Module N/A.

3.5.4 Launch Escape System No change.

3.5.5 Adapter

3.5.5.1 General The Adapter shall structurally and functionally adapt the spacecraft to the launch vehicle. A structural stiffener shall be used in place of the LEM.

3.5.5.2 Access The Adapter shall be designed to provide access to its interior during the prelaunch phase.

Apollo Saturn Missions 204 and 205

3.5.5.3 Deployment The Adapter shall be designed to permit normal CSM/Adapter separation and shall not interfere with launch vehicle or spacecraft communications.

3.5.6 Extravehicular Mobility Unit

3.5.6.1 General Spacesuits of anthropomorphous design shall be provided for the crew. These spacesuits shall provide, in conjunction with the ECS specified in 3.5.2.7, environmental protection, life support, communications, visibility and mobility.

3.5.6.2 Extravehicular N/A.

3.5.6.3 Intravehicular No change.

3.5.7 Scientific Payload The spacecraft shall be capable of supporting the in-flight experiments identified in Apollo Flight Mission Assignments, M-D MA 500-11.

3.5.8 Flight Crew Training Equipment No change.

3.6 Launch Area The requirements of this section, which are identified with LC 34 and the Direct Launch Support Facilities, are applicable without change. All other requirements of this section are not applicable.

3.7 Manned Space Flight Network

3.7.1 General No change.

Apollo Saturn Missions 204 and 205

3.7.2 Functional Capability No change except the LEM and EVA references are not applicable. Add to 3.7.2.3: (g) Track in angle and range the CSM radar transponders during flight.

3.7.3 Coverage Capability The MSFN station in the launch area shall be able to support the prelaunch checkout of the space vehicle on the launch pad.

The MSFN shall, in Apollo flight missions 204 and 205, provide the coverage capabilities for the:

(a) CSM as specified in Table 3.7-1 (204/205) of this appendix.

(b) Saturn IB launch vehicle as specified in Table 3.7-4 (204/205) of this appendix.

3.7.4 Performance No change except the MSFN shall operate with the space vehicle subsystems as specified in 3.3.5 and 3.5.2.3 of this appendix.

3.8 Mission Control Center No change.

4.0 Quality Assurance No change.

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APPENDIX 204

TABLE 3.3 - 1

SATURN IB LAUNCH VEHICLE COMMUNICATION AND TRACKING REQUIREMENTS

APOLLO-SATURN 204

STAGE / SUBSYSTEM	EQUIPMENT IMPLEMENTATION	NUMBER OF UNITS	OPERATING FREQUENCY TRANSMIT	OPERATING FREQUENCY RECEIVE	ANTENNA SUBSYSTEM	MODULATION CHARACTERISTICS	REMARKS
S-IB							
TELEMETRY	PCM/FM TELEMETER	ONE	225-260 Mc		OMNI-DIRECTIONAL	PCM/FM	• SEE NOTES 1, 2 AND 3 • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND
	FM/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF S-IB PCM/FM TELEMETER	FM/FM	• SEE NOTES 1 AND 4 • PAM/FM/FM MODULATION UTILIZED DURING R & D FLIGHT PROGRAM
	PAM/FM/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF S-IB PCM/FM TELEMETER	PAM/FM/FM	• SEE NOTES 1 AND 4
	SS/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF S-IB PCM/FM TELEMETER	SS/FM	• SEE NOTE 4
COMMAND DESTRUCT	RECEIVER AND DECODER	TWO		400-450 Mc	OMNI-DIRECTIONAL		• THIS SYSTEM SHALL BE COMPATIBLE WITH RANGE SAFETY COMMAND TRANSMITTERS INSTALLED AT STATIONS OF THE ETR.
TRACKING	ODOP TRANSPONDER	ONE	UHF	UHF	FIXED DIRECTIONAL		
S-IVB							
TELEMETRY	PCM/FM TELEMETER	ONE	225-260 Mc		OMNI-DIRECTIONAL	PCM/FM	• SEE NOTES 1, 2 AND 3 • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND
	FM/FM TELEMETER[6]	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF S-IVB PCM/FM TELEMETER	FM/FM	• SEE NOTES 1 AND 4 • PAM/FM/FM MODULATION UTILIZED DURING R & D FLIGHT PROGRAM
	PAM/FM/FM TELEMETER	TWO	225-260 Mc		SEE NOTE 5	PAM/FM/FM	• SEE NOTES 1 AND 4
	SS/FM TELEMETER	ONE	225-260 Mc		SEE NOTE 5	SS/FM	• SEE NOTE 4
COMMAND DESTRUCT	RECEIVER AND DECODER	TWO		400-450 Mc	OMNI-DIRECTIONAL		• THIS SYSTEM SHALL BE COMPATIBLE WITH RANGE SAFETY COMMAND TRANSMITTERS INSTALLED AT STATIONS OF THE ETR.
INSTRUMENT UNIT							
TELEMETRY	PCM/FM TELEMETER	ONE	225-260 Mc		OMNI-DIRECTIONAL	PCM/FM	• SEE NOTES 1, 2 AND 3 • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND • BIT STREAM SHALL CONTAIN ALL S-IVB/IU MISSION CONTROL DATA
	PCM/FM TELEMETER	ONE	2100-2300 Mc			PCM/FM	• SEE NOTES 1, 2 AND 3 • EXPERIMENTAL SYSTEM • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND • BIT STREAM SHALL BE IDENTICAL WITH IU VHF PCM/FM TELEMETER
	FM/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF IU VHF PCM/FM TELEMETER	FM/FM	• SEE NOTES 1 AND 4
	PAM/FM/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF IU VHF PCM/FM TELEMETER	PAM/FM/FM	• SEE NOTES 1 AND 4
	SS/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF IU VHF PCM/FM TELEMETER	SS/FM	• SEE NOTE 4
UP-DATA	RECEIVER AND DECODER	ONE		400-450 Mc	OMNI-DIRECTIONAL	PSK/FM	• SUBCODED 5-BIT WORDS AT 1000 BITS/SECOND • THE UP-DATA SUBSYSTEM SHALL BE DESIGNED IN CONJUNCTION WITH STATIONS OF THE MSFN SUCH THAT NO MORE THAN ONE CORRECT MESSAGE SHALL BE REJECTED PER 1000 CORRECT MESSAGES AND THAT NO MORE THAN ONE PER 10^8 INCORRECT MESSAGES SHALL BE ACCEPTED.
TRACKING	C-BAND RADAR TRANSPONDER	ONE	C-BAND	C-BAND	OMNI-DIRECTIONAL	PULSE	• UTILIZES CODING DIFFERENT FROM C-BAND RADAR TRANSPONDERS ON SPACECRAFT
	AZUSA TRANSPONDER	ONE	C-BAND	C-BAND	OMNI-DIRECTIONAL	FM	
TELEVISION	TELEVISION TRANSMITTER	ONE	S-BAND				

NOTES:

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1. THIS TELEMETRY SUBSYSTEM SHALL BE COMPATIBLE WITH THE INTER RANGE INSTRUMENTATION GROUP STANDARDS (IRIG DOCUMENT NO. 106-60. "TELEMETRY STANDARDS REVISED 1962")

2. ALL PCM TELEMETRY SUBSYSTEMS SHALL BE DESIGNED TO PROVIDE AN ERROR RATE NOT EXCEEDING ONE BIT IN 10^6 BITS FOR TRANSMISSIONS TO THE MSFN AS MEASURED FROM LAUNCH VEHICLE ENCODER TO EARTH-BASED DECODER.

3. THIS PCM TELEMETRY SUBSYSTEM SHALL BE CAPABLE OF TRANSMITTING THE PCM BIT STREAM REQUIRED FOR REAL-TIME USE VIA COAXIAL CABLE TO THE CHECKOUT FACILITY IN THE MILA PRIOR TO LIFT-OFF AND VIA AN RF LINK PRIOR TO AND AFTER LIFT-OFF.

4. THIS TELEMETRY SUBSYSTEM SHALL TRANSMIT DATA REQUIRED ONLY FOR POST-MISSION ANALYSIS VIA AN RF LINK.

5. UP TO 4 VHF STAGE TELEMETERS SHALL BE MULTIPLEXED ON A COMMON ANTENNA SUBSYSTEM. WHEN MORE THAN 4 VHF STAGE TELEMETERS ARE CARRIED, A SECOND OMNI-DIRECTIONAL ANTENNA SUBSYSTEM SHALL BE PROVIDED.

6. NOT PRESENTLY SCHEDULED FOR OPERATIONAL SATURN IB LAUNCH VEHICLES. HOWEVER, PROVISIONS TO CARRY THIS TELEMETER SHALL BE INCORPORATED ON ALL SATURN IB LAUNCH VEHICLES THROUGH AS-207.

EQUIPMENT/FUNCTION THIS FLIGHT	EQUIPMENT/FUNCTION OPERATIONAL VEHICLE	CODING
REQUIRED	REQUIRED	
REQUIRED	NOT REQUIRED	
NOT REQUIRED	REQUIRED	
NOT REQUIRED	NOT REQUIRED	

TABLE 3.3-1
APOLLO SATURN 204

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APPENDIX 204/205

TABLE 3.5-2A

CSM COMMUNICATIONS AND TRACKING REQUIREMENTS

APOLLO-SATURN 204/205

SUBSYSTEM	EQUIPMENT IMPLEMENTATION	NUMBER OF UNITS	OPERATING FREQUENCY		ANTENNA SUBSYSTEM	MODULATION CHARACTERISTICS	REMARKS
			TRANSMIT	RECEIVE			
VOICE COMMUNICATIONS (SEE NOTE 1)	UNIFIED S-BAND SYSTEM						● SEE TABLE 3.5-2B FOR REQUIREMENTS
WITH MSFN	VHF TRANSCEIVER #1	ONE	VHF	VHF	OMNI-DIRECTIONAL	DSBAM TRANSMIT DSBAM RECEIVE	● ALTERNATE NEAR-EARTH VOICE COMMUNICATIONS CHANNEL VIA SIMPLEX MODE OF OPERATION ● PRIMARY VOICE COMMUNICATIONS CHANNEL WITH LEM VIA SIMPLEX MODE OF OPERATION ● PRIMARY TRANSMITTER FOR DUPLEX VOICE COMMUNICATIONS WITH EVA ● ALTERNATE BACK-UP FOR VOICE COMMUNICATIONS WITH EVA VIA SIMPLEX MODE OF OPERATION ● ALTERNATE VOICE COMMUNICATIONS CHANNEL WITH RECOVERY FORCES VIA SIMPLEX MODE OF OPERATION ● PROVIDES BEACON MODE OF OPERATION FOR DF AFTER LANDING
WITH MSFN	VHF TRANSCEIVER #2		VHF	VHF	MULTIPLEXED WITH TRANSCEIVER #1	DSBAM TRANSMIT DSBAM RECEIVE	● UTILIZED FOR VOICE AND DATA TRANSMISSION SIMULATION DURING R & D FLIGHT PROGRAM ● SEE "VOICE COMMUNICATIONS WITH LEM"
WITH LEM	VHF TRANSCEIVER #1		VHF	VHF			● SEE "VOICE COMMUNICATIONS WITH MSFN"
WITH LEM	VHF TRANSCEIVER #2	ONE	VHF	VHF	MULTIPLEXED WITH TRANSCEIVER #1	DSBAM TRANSMIT DSBAM RECEIVE	● BACK-UP VOICE COMMUNICATIONS CHANNEL WITH LEM VIA SIMPLEX MODE OF OPERATION ● RECEIVES LEM PCM/AM DATA ● PRIMARY RECEIVER FOR DUPLEX VOICE COMMUNICATIONS WITH EVA ● RECEIVES EVA BIOMEDICAL DATA SIMULTANEOUSLY WITH EVA VOICE ● ALTERNATE BACK-UP FOR VOICE COMMUNICATIONS WITH EVA VIA SIMPLEX MODE OF OPERATIONS
WITH EVA	VHF TRANSCEIVER #1		VHF	VHF			● SEE "VOICE COMMUNICATIONS WITH MSFN"
WITH EVA	VHF TRANSCEIVER #2		VHF	VHF			● SEE "VOICE COMMUNICATIONS WITH LEM"
WITH RECOVERY FORCES	HF TRANSCEIVER	ONE	HF	HF	OMNI-DIRECTIONAL	AM, CW, SSB	● PROVIDES BEACON MODE OF OPERATION FOR DF AFTER LANDING ● HF RECOVERY ANTENNA DEPLOYED AFTER LANDING
WITH RECOVERY FORCES	VHF TRANSCEIVER #1		VHF	VHF	MULTIPLEXED WITH VHF BEACON ANTENNA AFTER ENTRY		● SEE "VOICE COMMUNICATIONS WITH MSFN"
KEYING COMMUNICATIONS TO MSFN	UNIFIED S-BAND SYSTEM						● SEE TABLE 3.5-2B FOR REQUIREMENTS
TELEMETRY TO MSFN	UNIFIED S-BAND SYSTEM						● SEE TABLE 3.5-2B FOR REQUIREMENTS
TO MSFN	VHF TRANSCEIVER #2		VHF				● UTILIZED FOR VOICE AND DATA TRANSMISSION SIMULATION DURING R & D FLIGHT PROGRAM ● SEE "VOICE COMMUNICATIONS WITH LEM"
TO MSFN	PCM/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH TRANSCEIVER #1	PCM/FM NRZ-C SERIAL BIT STREAM	● SEE NOTES 2, 3 AND 5 ● SELECTABLE BIT RATES OF 51.2 KILOBITS/SECOND AND 1.6 KILOBITS/SECOND ● ALSO PROVIDES PLAYBACK OF RECORDED CSM PCM TELEMETRY
TO MSFN	PAM/FM/FM TELEMETER	TWO	225-260 Mc		MULTIPLEXED WITH TRANSCEIVER #1	PAM/FM/FM	● TRANSMITS DATA REQUIRED ONLY FOR POST-FLIGHT ANALYSIS ● SEE NOTE 3
TO MSFN	FM TELEMETER	ONE	225-260 Mc			PCM/FM OR FM/FM	● CARRIED AS-205 ONLY. ● SEE NOTE 3
FROM LEM	VHF TRANSCEIVER #2			VHF		PCM/AM	● SEE "VOICE COMMUNICATIONS WITH LEM" ● SEE NOTE 4 ● PCM BIT RATE OF 1.6 KILOBITS/SECOND
FROM EVA	VHF TRANSCEIVER #2			VHF		FM/AM.	● SEE "VOICE COMMUNICATIONS WITH LEM"
TAPE PLAYBACK TO MSFN	UNIFIED S-BAND SYSTEM						● SEE TABLE 3.5-2B FOR REQUIREMENTS
TO MSFN	PCM/FM TELEMETER		225-260 Mc				● SEE "TELEMETRY TO MSFN"
TO MSFN	PCM/FM TELEMETER	ONE	225-260 Mc			PCM/FM	● TRANSMITS RECORDED PCM/FM DATA ● SEE NOTES 2, 3 AND 5
TELEVISION TO MSFN	UNIFIED S-BAND SYSTEM						● SEE TABLE 3.5-2B FOR REQUIREMENTS
UP-DATA (SEE NOTE 6) FROM MSFN	UNIFIED S-BAND SYSTEM						● SEE TABLE 3.5-2B FOR REQUIREMENTS
FROM MSFN	RECEIVER AND DECODER	ONE		400-450 Mc	UTILIZES TRANSCEIVER #1 IN-FLIGHT ANTENNA	PSK/FM	● SUBCODED 5-BIT WORDS AT 1000 BITS/SECOND
TRACKING AID TO MSFN	UNIFIED S-BAND SYSTEM						● SEE TABLE 3.5-2B FOR REQUIREMENTS
TO MSFN	C-BAND RADAR TRANSPONDER	ONE	C-BAND	C-BAND	OMNI-DIRECTIONAL	PULSE	● UTILIZES CODING DIFFERENT FROM LAUNCH VEHICLE AND LEM C-BAND RADAR TRANSPONDERS
TO LEM	RENDEZVOUS RADAR TRANSPONDER	ONE	X-BAND	X-BAND	OMNI-DIRECTIONAL	PM RECEIVE PM TRANSMIT	● THREE-TONE RANGE CODE AND COHERENT CARRIER TURN-AROUND
BEACON TO RECOVERY FORCES	VHF BEACON	ONE	VHF		OMNI-DIRECTIONAL	AM	● VHF RECOVERY ANTENNA DEPLOYED AT MAIN CHUTE DEPLOYMENT ● BEACON IS MULTIPLEXED WITH TRANSCEIVER #1 AFTER ENTRY
TO RECOVERY FORCES	HF TRANSCEIVER		HF				● SEE "VOICE COMMUNICATIONS WITH RECOVERY FORCES"
TO RECOVERY FORCES	VHF TRANSCEIVER #1		VHF		MULTIPLEXED WITH VHF BEACON ANTENNA AFTER ENTRY		● SEE "VOICE COMMUNICATIONS WITH MSFN"

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NOTES:

1. THE MINIMUM WORD INTELLIGIBILITY SHALL BE 90% FOR NORMAL VOICE COMMUNICATIONS AND 70% FOR BACK-UP COMMUNICATIONS AS MEASURED BY USER PERSONNEL UNDER SIMULATED OPERATING CONDITIONS UTILIZING THE AMERICAN STANDARD METHOD FOR MEASUREMENT OF MONOSYLLABIC WORD INTELLIGIBILITY DATED MAY 25, 1960.
2. THE TELEMETRY SUBSYSTEM SHALL BE DESIGNED TO PROVIDE AN ERROR RATE NOT EXCEEDING ONE BIT IN 10^6 BITS FOR TRANSMISSIONS TO THE MSFN AS MEASURED FORM CSM ENCODER TO MSFN DECODER.
3. THIS TELEMETRY SUBSYSTEM SHALL BE COMPATIBLE WITH THE INTER RANGE INSTRUMENTATION GROUP STANDARDS (IRIG DOCUMENT NO. 106-60, "TELMETRY STANDARDS REVISED 1962")
4. THE TELEMETRY SUBSYSTEM SHALL BE DESIGNED TO PROVIDE AN ERROR RATE NOT EXCEEDING ONE BIT IN 10^6 BITS FOR PCM TELEMETRY TRANSMISSION TO THE CSM AS MEASURED FROM LEM ENCODER TO THE CSM RECORDER.
5. THIS PCM TELEMETRY SUBSYSTEM SHALL BE BE CAPABLE OF TRANSMITTING THE PCM BIT STREAM REQUIRED FOR REAL-TIME USE VIA COAXIAL CABLE TO THE CHECKOUT FACILITY IN THE MILA PRIOR TO LIFT-OFF AND VIA AN RF LINK PRIOR TO AND AFTER LIFT-OFF.
6. NO MORE THAN ONE CORRECT MESSAGE SHALL BE REJECTED PER 1000 CORRECT MESSAGES AND NO MORE THAN ONE PER 10^9 INCORRECT MESSAGES SHALL BE ACCEPTED.

LEGEND

EQUIPMENT/FUNCTION		CODING
THIS FLIGHT	LUNAR MISSION	
REQUIRED	REQUIRED	
REQUIRED	NOT REQUIRED	
NOT REQUIRED	REQUIRED	
NOT REQUIRED	NOT REQUIRED	

TABLE 3.5-2A
APOLLO-SATURN 204/205

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APPENDIX 204/205

TABLE 3.5-2B

CSM UNIFIED S-BAND COMMUNICATIONS AND TRACKING REQUIREMENTS

APOLLO-SATURN 204/205

SUBSYSTEM	EQUIPMENT IMPLEMENTATION	NUMBER OF UNITS	OPERATING FREQUENCY TRANSMIT	OPERATING FREQUENCY RECEIVE	ANTENNA SUBSYSTEM	MODULATION CHARACTERISTICS	REMARKS
VOICE COMMUNICATIONS (SEE NOTE 1) WITH MSFN	PM TRANSPONDER	TWO	S-BAND	S-BAND	OMNI-DIRECTIONAL DIRECTIONAL - VARIABLE BEAMWIDTH	FM/PM TRANSMIT - 1.25 Mc SUBCARRIER FM/PM RECEIVE 30 Kc SUBCARRIER	● TRANSPONDER FREQUENCY SHALL BE COHERENT WITH SIGNALS RECEIVED FROM THE MSFN AND IN THE RATIO OF 240:221 ● RELAY VOICE AND TELEMETRY COMMUNICATIONS WITH EVA ● BACKUP RELAY OF VOICE COMMUNICATIONS WITH LEM ● TRANSPONDER ALSO PROVIDES FOR TELEMETRY TRANSMISSION, KEYED TRANSMISSION, UP-DATA RECEPTION AND TRACKING ASSISTANCE TO THE MSFN,
						PM TRANSMIT AT BASEBAND	● EMERGENCY VOICE TRANSMISSION ● THIS CAPABILITY IS PROVIDED ONLY WHEN THE CAPABILITY FOR SIMULTANEOUS PM AND FM S-BAND TRANSMISSION IS PROVIDED.
						FM/PM RECEIVE 70 Kc SUBCARRIER	● EMERGENCY VOICE RECEPTION ● THIS CAPABILITY IS PROVIDED ONLY WHEN THE CAPABILITY FOR SIMULTANEOUS PM AND FM S-BAND TRANSMISSION IS PROVIDED ● SEE "UP-DATA FROM MSFN"
WITH MSFN	FM TRANSMITTER #1	ONE	S-BAND		MULTIPLEXED WITH S-BAND TRANSPONDER OMNI-DIRECTIONAL ANTENNA SYSTEM	FM/FM TRANSMIT 1.25 Mc SUBCARRIER	● THIS TRANSMITTER OPERATES ON THE SAME FREQUENCY AS THE TRANSPONDER, THEREFORE IT IS PROVIDED ONLY ON THOSE FLIGHTS FOR WHICH SIMULTANEOUS PM AND FM S-BAND TRANSMISSION IS NOT REQUIRED. ● VOICE RECEPTION IS ACHIEVED VIA PM RECEPTION OF 30 Kc FM SUBCARRIER. ● TRANSMITTER ALSO PROVIDES FOR TELEMETRY, SCIENTIFIC DATA, TELEVISION, AND TAPE PLAYBACK TRANSMISSION TO THE MSFN.
KEYING COMMUNICATIONS TO MSFN	PM TRANSPONDER		S-BAND			AM/PM 512 Kc SUBCARRIER	● SEE "VOICE COMMUNICATIONS WITH MSFN" ● TRANSMITTED ALONE - BACKUP FOR VOICE TRANSMISSION
TELEMETRY TO MSFN	PM TRANSPONDER		S-BAND			PCM/PM/PM 1.024 Mc SUBCARRIER NRZ-C SERIAL BIT STREAM	● SEE "VOICE COMMUNICATIONS WITH MSFN" ● SELECTABLE BIT RATES OF 51.2 KILOBITS/SECOND AND 1.6 KILOBITS/SECOND ● SEE NOTES 2 AND 3
						FM/FM/PM 7 SUBCARRIERS ON 1.25 Mc VOICE SUBCARRIER	● SEE "VOICE COMMUNICATIONS WITH MSFN" ● RELAY OF COMPOSITE EVA VOICE AND 7 CHANNELS OF EVA TELEMETRY ON VOICE SUBCARRIER WHEN SIMULTANEOUS PM AND FM S-BAND TRANSMISSION CAPABILITY IS PROVIDED.
TO MSFN	FM TRANSMITTER #1		S-BAND			PCM/PM/FM 1.024 Mc SUBCARRIER NRZ-C SERIAL BIT STREAM	● SEE "VOICE COMMUNICATIONS WITH MSFN" ● SELECTABLE BIT RATES OF 51.2 KILOBITS/SECOND AND 1.6 KILOBITS/SECOND ● SEE NOTES 2 AND 3
						FM/FM 95 Kc, 125 Kc, 165 Kc SUBCARRIERS	● SEE "VOICE COMMUNICATIONS WITH MSFN" ● PROVIDES 3 CHANNELS OF REAL TIME SCIENTIFIC DATA TRANSMISSION TO THE MSFN ● SIX ADDITIONAL SUBCARRIERS ARE ALSO AVAILABLE
TO MSFN	FM TRANSMITTER #2	ONE	S-BAND		MULTIPLEXED WITH S-BAND TRANSPONDER ANTENNA SYSTEM	FM/FM 95 Kc, 125 Kc, 165 Kc SUBCARRIERS	● THIS TRANSMITTER IS PROVIDED ONLY ON THOSE FLIGHTS FOR WHICH SIMULTANEOUS PM AND FM S-BAND TRANSMISSION IS REQUIRED. ● TRANSMITTER ALSO PROVIDES FOR TELEVISION AND TAPE PLAYBACK TRANSMISSION TO THE MSFN. ● PROVIDES 3 CHANNELS OF REAL TIME SCIENTIFIC DATA TRANSMISSION TO THE MSFN
TAPE PLAYBACK TO MSFN	FM TRANSMITTER #1		S-BAND				● SEE "VOICE COMMUNICATIONS WITH MSFN"
						FM/FM 95 Kc, 125 Kc, 165 Kc SUBCARRIERS	● RECORDED SCIENTIFIC DATA - 3 CHANNELS ● SIX ADDITIONAL CHANNELS ARE ALSO AVAILABLE
						FM/FM ANALOG SUBCARRIER	● RECORDED VOICE
						PCM/PM/FM 1.024 Mc SUBCARRIER	● RECORDED CSM PCM TELEMETRY AT APPARENT 51.2 KILOBITS/SECOND RATE
TO MSFN	FM TRANSMITTER #2		S-BAND				● SEE "TELEMETRY TO MSFN"
						FM/FM 95 Kc, 125 Kc, 165 Kc SUBCARRIERS	● RECORDED SCIENTIFIC DATA - 3 CHANNELS
						FM AT BASEBAND	● RECORDED VOICE
						PCM/PM/FM 1.024 Mc SUBCARRIER	● RECORDED CSM PCM TELEMETRY AT APPARENT 51.2 KILOBITS/SECOND
						FM AT BASEBAND	● RECORDED LEM 1.6 KILOBITS /SECOND PCM TELEMETRY AT APPARENT 51.2 KILOBITS/SECOND
TELEVISION TO MSFN	FM TRANSMITTER #1		S-BAND			FM AT BASEBAND	● SEE "VOICE COMMUNICATIONS WITH MSFN"
TO MSFN	FM TRANSMITTER #2		S-BAND			FM AT BASEBAND	● SEE "TELEMETRY TO MSFN"
UP-DATA (SEE NOTE 4) FROM MSFN	PM TRANSPONDER			S-BAND		PSK/FM/PM 70 Kc SUBCARRIER	● SEE "VOICE COMMUNICATIONS WITH MSFN" ● SUBCODED 5-BIT WORDS AT 1000 BITS/SECOND
TRACKING AID TO MSFN	PM TRANSPONDER		S-BAND	S-BAND		PM RECEIVE- PRN CODE AT BASEBAND PM TRANSMIT- PRN CODE AT BASEBAND	● SEE "VOICE COMMUNICATIONS WITH MSFN" ● COHERENT TURN-AROUND CARRIER ● COHERENT TURN-AROUND RANGE CODE

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NOTES:

1. THE MINIMUM WORD INTELLIGIBILITY SHALL BE 90% FOR NORMAL VOICE COMMUNICATIONS AND 70% FOR BACK-UP COMMUNICATIONS AS MEASURED BY USER PERSONNEL UNDER SIMULATED OPERATING CONDITIONS UTILIZING THE AMERICAN STANDARD METHOD FOR MEASUREMENT OF MONOSYLLABIC WORD INTELLIGIBILITY DATED MAY 25, 1960

2. THE TELEMETRY SUBSYSTEM SHALL BE DESIGNED TO PROVIDE AN ERROR RATE NOT EXCEEDING ONE BIT IN 10^6 BITS FOR PCM TELEMETRY TRANSMISSIONS TO STATIONS OF THE MSFN AS MEASURED FROM CSM ENCODER TO MSFN DECODER.

3. THE PCM TELEMETRY SUBSYSTEM SHALL BE CAPABLE OF TRANSMITTING THE PCM BIT STREAM REQUIRED FOR REAL-TIME USE VIA COAXIAL CABLE TO THE CHECKOUT FACILITY IN THE MILA PRIOR TO LIFT-OFF AND VIA AN RF LINK PRIOR TO AND AFTER LIFT-OFF.

4. THE UP-DATA SUBSYSTEM SHALL BE DESIGNED IN CONJUNCTION WITH STATIONS OF THE MSFN SUCH THAT NO MORE THAN ONE CORRECT MESSAGE SHALL BE REJECTED PER 1000 CORRECT MESSAGES AND THAT NO MORE THAN ONE PER 10^9 INCORRECT MESSAGES SHALL BE ACCEPTED.

LEGEND

EQUIPMENT/FUNCTION THIS FLIGHT	EQUIPMENT/FUNCTION LUNAR MISSION	CODING
REQUIRED	REQUIRED	
REQUIRED	NOT REQUIRED	
NOT REQUIRED	REQUIRED	
NOT REQUIRED	NOT REQUIRED	

TABLE 3.5-2B
APOLLO-SATURN 204/205

APPENDIX 204/205
TABLE 3.7-1
REQUIRED CSM COVERAGE
APOLLO-SATURN 204/205

SUBSYSTEM \ PHASE	S-IB BURN	S-IVB BURN	END OF S-IVB BURN +3 MINUTES	COAST IN EARTH ORBIT	S/C - LV SEPARATION [2]	-2 MINUTES TO INITIAL SPS BURN	INITIAL SPS BURN	EXTENDED FLIGHT: MISSION OPERATIONS	EXTENDED FLIGHT: SPS BURNS	CM SEPARATION	CM ENTRY
VHF											
VOICE	Continuous coverage	Continuous coverage	Continuous coverage	Partial coverage [1]	Continuous coverage	Continuous coverage	Continuous coverage	COVERAGE REQUIREMENTS TO BE SUPPLIED	Not required	Continuous coverage	Partial coverage
TELEMETRY	Continuous coverage	Continuous coverage	Continuous coverage	Partial coverage [1]	Continuous coverage	Continuous coverage	Continuous coverage		Not required	Continuous coverage	Partial coverage
UHF											
UP-DATA	Continuous coverage	Continuous coverage	Continuous coverage	Partial coverage [1]	Continuous coverage	Continuous coverage	Continuous coverage		Not required	Continuous coverage	Partial coverage
C-BAND											
TRACKING	Not required	Not required	Not required	Partial coverage [1]	Continuous coverage	Continuous coverage	Partial coverage		Not required	Not required	Partial coverage
S-BAND											
VOICE	Partial coverage	Partial coverage	Partial coverage	Partial coverage	Partial coverage	Partial coverage	Partial coverage		Partial coverage	Partial coverage	Partial coverage
TELEMETRY	Partial coverage	Partial coverage	Partial coverage	Partial coverage	Partial coverage	Partial coverage	Partial coverage		Partial coverage	Partial coverage	Partial coverage
UP-DATA	Partial coverage	Partial coverage	Partial coverage	Partial coverage	Partial coverage	Partial coverage	Partial coverage		Partial coverage	Partial coverage	Partial coverage
TRACKING	Partial coverage	Partial coverage	Partial coverage	Partial coverage	Partial coverage	Partial coverage	Partial coverage		Partial coverage	Partial coverage	Partial coverage
TELEVISION	Not required	Not required	Not required	Partial coverage	Not required	Not required	Not required		Not required	Not required	Not required

1. GAP BETWEEN CONTACTS SHALL BE NO GREATER THAN 1/2 ORBIT CONTACTS SHALL BE AT LEAST 3 MINUTES LONG.

2. THIS REQUIREMENT MAY BE SATISFIED DURING AN ORBITAL CONTACT.

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PARTIAL COVERAGE
CONTINUOUS COVERAGE
NOT REQUIRED

TABLE 3.7-1
APOLLO-SATURN 204/205

APPENDIX 204/205
TABLE 3.7-4
REQUIRED SATURN IB LAUNCH VEHICLE COVERAGE
APOLLO-SATURN 204/205

SUBSYSTEM \ PHASE	S-IB BURN	S-IVB BURN	END OF S-IVB BURN +3 MINUTES	COAST IN EARTH ORBIT [4]	S-IVB/IU CHECKOUT IN EARTH ORBIT [5]	SPACECRAFT SEPARATION [5]
VHF TELEMETRY						
S-IB	1					
S-IVB				////		
IU				////		
TELEMETRY [6]						
IU	////	////	////	////		
COMMAND DESTRUCT						
S-IB	2					
S-IVB		//// 2				
UHF UP-DATA						
IU	////	////		////		
TRACKING						
C-BAND		3		////		
ODOP	//// 3					
AZUSA	////	//// 3				

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1 COVERAGE SHALL CONTINUE FOR AT LEAST ONE MINUTE AFTER THE END OF BURN.

2 CONTINUOUS COVERAGE UNTIL THE PREDICTED IMPACT POINT OF THE VEHICLE IS OUTSIDE AREAS SPECIFIED BY RANGE SAFETY.

3 TWO LAUNCH VEHICLE TRANSPONDERS SHALL BE TRACKED CONTINUOUSLY TO SATISFY RANGE SAFETY REQUIREMENTS.

4 THE GAP BETWEEN CONTACTS SHALL BE NO GREATER THAN 1/2 ORBIT. CONTACTS SHALL BE AT LEAST 3 MINUTES LONG.

5 THIS REQUIREMENT MAY BE SATISFIED DURING AN ORBITAL CONTACT.

6 EXPERIMENTAL SYSTEM - NOT REQUIRED ON AS-205.

//// PARTIAL COVERAGE

CONTINUOUS COVERAGE

NOT REQUIRED

TABLE 3.7-4
APOLLO-SATURN 204/205

Apollo Saturn Mission 206

1.0 Scope This appendix to the Apollo Program Specification identifies the performance, design and test requirements which apply to the Program elements to be utilized for Apollo Saturn Mission 206 (AS-206). These requirements are presented in this appendix as deviations to the requirements specified in the body of the specification. Unless otherwise noted, the paragraphs in this appendix replace in their entirety the identically numbered paragraphs in the body of the specification.

1.1 Applicability No change.(1)

1.2 Change Approval No change.

2.0 Applicable Documents No change.

3.0 Requirements

3.1 Performance

3.1.1 Characteristics

3.1.1.1 General Add: To the extent practicable, the hardware used on AS-206 shall be of the same design as the operational version.

(1) The phrase "no change" is used after a section heading throughout this appendix to mean that the requirement in the body of the specification applies to this mission without change.

Apollo Saturn Mission 206

3.1.1.2 Mission Performance

3.1.1.2.1 Mission Mode For this mission an unmanned Apollo spacecraft, which includes a boilerplate CSM and a LEM, shall be launched from the Cape Kennedy launch area (LC 37B) by a Saturn IB launch vehicle. The Saturn IB consists of an S-IB first stage, an S-IVB (Saturn IB version) second stage and an IU (Saturn IB version). The boilerplate CSM shall be separated from the remainder of the space vehicle by the Launch Escape System during the ascent to Earth orbit. After insertion into Earth orbit, the LEM shall be separated from the remainder of the space vehicle and both the ascent and descent stages operated while in Earth orbit. No recovery of flight hardware is required.

3.1.1.2.2 Mission Command A Mission Control Programmer shall be provided on board the LEM which, in conjunction with the LEM guidance computer, shall provide spacecraft commands as necessary for accomplishment of the mission. The Mission Control Programmer shall be capable, independent of the LEM guidance computer, of receiving signals from ground-based personnel as a backup. The MSFN shall be used for communication with the space vehicle, including up-data transmission and television, telemetry and simulated voice reception, and for tracking of the space vehicle (the existing configuration of launch vehicle stages and spacecraft modules at a given point in the mission) during the mission.

3.1.1.2.3 Payload The payload for this mission shall include a boilerplate CSM and a LEM. The objectives shall include those identified in Apollo Flight Mission Assignments, M-D MA 500-11.

3.1.1.2.4 Earth Launch Launch capability shall be provided to permit an initial flight azimuth of 072°.

Apollo Saturn Mission 206

3.1.1.2.5 Earth Parking Orbit The capability shall be provided to perform the mission using an elliptical orbit with a nominal apogee of 120 nm and a nominal perigee of 85 nm (after S-IVB insertion) and higher altitude orbits, not to exceed 300 nm, using the LEM for maneuvering subsequent to separation from the launch vehicle.

3.1.1.2.6 Injection Opportunities Not applicable (N/A).(2)

3.1.1.2.7 Lunar Landing Accuracy N/A. See 3.1.1.1 (AS-206).

3.1.1.2.8 Lunar Exploration N/A.

3.1.1.2.9 Earth Landing N/A.

3.1.1.2.10 Recovery N/A.

3.1.2 Program Definition No change.

3.1.3 Operability

3.1.3.1 Logistics No change.

3.1.3.2 Safety No change.

3.1.3.3 Reliability The numerical reliability values for mission success given in Table 3.1-2 shall be used where applicable for engineering design and as a standard for evaluating test results. The success probability for the S-IB stage shall be at least 0.95.

On Table 3.1-2 change note 1 to: The preflight phase begins with the decision to start the countdown for launch and ends with launch. Change note 2 to: The flight phase begins with space vehicle liftoff from the launch pad and terminates with conclusion of the LEM experiments.

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(2) The phrase "not applicable" is used after a section heading throughout this appendix to mean that the requirement in the body of the specification does not apply to this mission.

Apollo Saturn Mission 206

3.2 Program Standards No change.

3.3 Saturn IB Launch Vehicle

3.3.1 General No change except launch vehicle control weights shall be as specified for AS-206 in Table 10.1-1, Appendix 10.1.

3.3.1.1 Payload The launch vehicle shall provide the payload capability specified for AS-206 in Table 10.1-1, Appendix 10.1.

3.3.1.2 Standby Time No change.

3.3.1.3 Prelaunch Checkout No change.

3.3.1.4 In-Flight Performance Evaluation No change.

3.3.1.5 Emergency Detection Subsystem No change except that EDS information shall not be provided for display to the crew and the EDS shall be operated in an open-loop mode.

3.3.1.6 Instrumentation Delete reference to the crew.

3.3.1.7 Command Destruct No change.

3.3.1.8 Electrical Power No change.

3.3.2 Structure No change.

3.3.2.1 Prelaunch Environment No change.

3.3.2.2 Launch and Flight Environment The launch vehicle shall be capable of being launched in the 90 percentile peak surface wind conditions given in 2.3.2.3 of M-DE 8020.008B and associated wind shears given in 2.3.2.4 of M-DE 8020.008B. The launch vehicle shall be capable of flight in the 95 percentile quasi-steady state in-flight winds given in 2.3.2.5 of M-DE 8020.008B. In addition, the vehicle shall be capable of flight with 85 percent of the 99 percentile wind shears given in 2.3.2.5 of M-DE 8020.008B, and with 85 percent of the quasi-square wave gust given in 2.3.2.8 of M-DE 8020.008B, both superimposed on the 95 percentile quasi-steady state in-flight winds given in 2.3.2.5 of M-DE 8020.008B.

3.3.3 Propulsion No change.

3.3.4 Launch Vehicle Guidance, Navigation and Control

3.3.4.1 General The launch vehicle guidance, navigation and control system shall provide the guidance, navigation and control functions which are required for the space vehicle from liftoff through separation of the LEM from the launch vehicle. The principal elements shall be an inertial measurement unit (IMU), a digital computer and control electronics. These elements shall be located in the IU.

3.3.4.1.1 No change.

3.3.4.1.2 N/A.

3.3.5 Saturn IB Launch Vehicle Communications and Tracking

3.3.5.1 General Add: (e) Television transmission.

3.3.5.2 Functional Capability Add the following paragraph:

3.3.5.2.5 Television A television subsystem shall be provided in the IU which shall be able to provide television coverage of the separation of the LEM from the S-IVB/IU.

3.3.5.3 Coverage Capability The Saturn IB Communication and Tracking System shall be able to operate with the MSFN to achieve the coverage specified in Table 3.7-4 (206) of this appendix.

Apollo Saturn Mission 206

3.3.5.4 Performance The Saturn IB Communication and Tracking System shall meet the requirements specified in Table 3.3-1 (206) of this appendix.

3.4 Saturn V Launch Vehicle N/A.

3.5 Spacecraft

3.5.1 General The spacecraft shall be composed of a boilerplate CSM, a LES, an Adapter and a LEM. The spacecraft shall be designed to be mated to a Saturn IB launch vehicle. The boilerplate CSM shall act as an aerodynamic shroud during the initial phase of the launch and will be jettisoned with the LES. The LEM shall be composed of an ascent stage and a descent stage.

Spacecraft control weights shall be as specified for AS-206 in Table 10.1-3, Appendix 10.1.

3.5.1.1 Prelaunch Environment No change.

3.5.1.2 Prelaunch Checkout No change.

3.5.1.3 In-Flight Performance Evaluation No change.

3.5.1.4 Standby Time The spacecraft shall have the capability to stand by in a loaded condition, after launch vehicle propellant loading, for 10 hours and still perform the mission.

3.5.1.5 Launch and Flight Environment The spacecraft shall be capable of being launched in the 90 percentile peak surface wind conditions given in 2.3.2.3 of M-DE 8020.008B and associated wind shears given in 2.3.2.4 of M-DE 8020.008B. The spacecraft shall be capable of flight in the 95 percentile quasi-steady state in-flight winds given in 2.3.2.5 of M-DE 8020.008B. In addition, the spacecraft shall be capable of flight with 85 percent of the 99 percentile wind shears given in 2.3.2.6 of M-DE 8020.008B, and with 85 percent of the quasi-square wave gust given in 2.3.2.8 of M-DE 8020.008B, both superimposed on the 95 percentile quasi-steady state in-flight winds given in 2.3.2.5 of M-DE 8020.008B.

3.5.1.6 Earth Orbit Environment No change.

3.5.1.7 Translunar Environment N/A. See 3.1.1.1 (AS-206).

3.5.1.8 Transposition N/A.

3.5.1.9 One-Man Operation N/A.

3.5.1.10 CSM/LEM Abort N/A.

3.5.1.11 Separation Time All LEM subsystems shall be capable of meeting their performance requirements, while separated from the S-IVB and Adapter, for at least the time necessary to achieve the objectives specified in 3.1.1.2.3 (AS-206).

3.5.1.12 Descent Abort N/A.

3.5.1.13 Translational Range N/A.

3.5.1.14 Lunar Environment N/A. See 3.1.1.1 (AS-206).

3.5.1.15 Lunar Landing N/A. See 3.1.1.1 (AS-206).

3.5.1.16 Lunar Operations The LEM shall be capable of accommodating the temperature of lunar day as given in 5.7 of M-DE 8020.008B.

3.5.1.17 Scientific Equipment Support N/A.

3.5.1.18 Sterilization No change.

3.5.1.19 Launch Platform N/A.

3.5.1.20 Ascent Stage Operations Using the LEM Ascent Propulsion Subsystem, the ascent stage shall be capable of separating from the descent stage during Earth orbit. The ascent stage shall be capable of operation independent of the descent stage for at least the time necessary to achieve the objectives specified in 3.1.1.2.3 (AS-206).

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Apollo Saturn Mission 206

3.5.1.21 Rendezvous and Dock N/A.

3.5.1.22 Entry N/A.

3.5.1.23 Aerodynamic Characteristics N/A.

3.5.1.24 Landing N/A.

3.5.1.25 Postlanding N/A.

3.5.1.26 Recovery N/A.

3.5.2 Command and Service Modules A boilerplate CSM will be used as an aerodynamic shroud during the initial phase of the mission. It will be jettisoned with the LES.

3.5.3 Lunar Excursion Module

3.5.3.1 Structure

3.5.3.1.1 Cabin Space N/A. See 3.1.1.1 (AS-206).

3.5.3.1.2 Windows N/A. See 3.1.1.1 (AS-206).

3.5.3.1.3 Ingress and Egress N/A. See 3.1.1.1 (AS-206).

3.5.3.1.4 Docking N/A.

3.5.3.1.5 Thermal Requirements No change.

3.5.3.1.6 EMU Storage N/A.

3.5.3.2 LEM Propulsion

3.5.3.2.1 General No change except that ΔV numbers in Table 3.5-1 are not applicable.

3.5.3.2.2 LEM Reaction Control Subsystem The LEM RCS shall provide thrust for translation along three axes and attitude control about three axes during descent and ascent engine operations. There shall be two separate, redundant subsystems. See 3.1.1.1 (AS-206).

3.5.3.2.3 LEM Descent Propulsion Subsystem The LEM Descent Propulsion Subsystem shall provide the propulsion necessary to support the mission requirements of 3.1.1.2.3 (AS-206).

3.5.3.2.4 LEM Ascent Propulsion Subsystem The LEM Ascent Propulsion Subsystem shall provide the propulsion necessary to support the mission requirements of 3.1.1.2.3 (AS-206).

3.5.3.3 LEM Communications and Tracking

3.5.3.3.1 General The LEM Communication and Tracking System shall provide the following capabilities:

(a) Simulated voice communications.

(b) Telemetry transmission and reception.

(c) Tracking aid.

(d) Up-data reception.

3.5.3.3.2 Functional Capability

3.5.3.3.2.1 Voice Communication The voice communication subsystem shall be able to provide simulated voice communications from the LEM to the MSFN.

3.5.3.3.2.2 Telemetry The telemetry subsystem shall be able to:

(a) Transmit operational data from the LEM to the MSFN at a high and a low bit data rate.

(b) Transmit the data required for postflight analysis.

3.5.3.3.2.3 Tracking and Tracking Aid The tracking aid subsystem shall enable the MSFN to track the LEM.

3.5.3.3.2.4 Television N/A.

3.5.3.3.2.5 Up-Data The up-data subsystem shall be able to:

(a) Receive data from the MSFN.

(b) Supply up-data verification signals to the MSFN via the LEM telemetry subsystem.

Apollo Saturn Mission 206

3.5.3.3.3 Coverage Capability

3.5.3.3.3.1 LEM-MSFN The LEM Communication and Tracking System shall be able to operate with the MSFN to achieve the coverage specified in Table 3.7-2 (206) of this appendix.

3.5.3.3.3.2 LEM-CSM N/A.

3.5.3.3.3.3 LEM-EVA N/A.

3.5.3.3.3.4 LEM-Lunar Surface N/A.

3.5.3.3.4 Performance The LEM Communication and Tracking System shall meet the requirements specified in Tables 3.5-4A (206) and 3.5-4B (206) of this appendix.

3.5.3.4 Electrical Power Subsystem

3.5.3.4.1 General The LEM EPS shall distribute the electrical power required by the LEM during all phases of the mission. The source of power shall be EPS batteries located in the ascent and descent stages.

3.5.3.4.2 Sizing The power generation subsystem shall contain four descent-stage batteries and two ascent-stage batteries.

3.5.3.4.3 Nominal Capacity No change.

3.5.3.4.4 Pyrotechnic Firing Circuits No change.

3.5.3.4.5 Ground Support No change.

3.5.3.5 Integrated Navigation, Guidance and Control System

3.5.3.5.1 General The navigation, guidance and control system shall be composed of the LEM Primary Navigation, Guidance and Control System (PNGCS) and the LEM Stabilization and Control System (SCS) with common usage of some elements.

The PNGCS and the SCS shall be used in conjunction with the Mission Control Programmer (MCP) to provide the LEM with the capability of executing unmanned Apollo Saturn 206 flight sequences after LEM separation from the rest of the space vehicle. The MCP and SCS shall also provide LEM control in the event of PNGCS failure.

LEM control during the mission shall be provided by the LEM Guidance Computer in conjunction with the MCP. The guidance computer shall initiate LEM guidance and control functions. As a backup, the MCP shall be able to accept certain discrete ground commands independent of the PNGCS so as to provide LEM control.

3.5.3.5.1.1 The principal elements of the PNGCS shall be an IMU, a digital computer, an optical subsystem and controls.

3.5.3.5.1.2 The principal elements of the SCS shall be gyroscopes, an accelerometer rigidly mounted to the LEM structure, control electronics and controls.

3.5.3.5.1.3 The PNGCS shall provide means for checkout on the launch pad utilizing the prelaunch checkout equipment.

3.5.3.5.1.4 The PNGCS shall:

(a) Permit the guidance computer to accept command and navigation data from the MSFN via up-data link.

(b) Provide for prelaunch alignment of the PNGCS IMU.

3.5.3.5.2 Accuracy N/A. See 3.1.1.1 (AS-206).

3.5.3.6 Display and Control (D&C) Subsystem N/A.

3.5.3.7 Environmental Control Subsystem The LEM shall be equipped with a nonregenerative ECS which shall provide a conditioned atmosphere, water management and thermal control of equipment when needed.

3.5.3.7.1 Extravehicular Operations N/A.

3.5.3.7.2 Atmospheric Supply No change except delete references to the crew.

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3.5.3.7.3 Water Management Water shall be stored on board at launch for maintaining thermal control of equipment.

3.5.3.7.4 EMU Support N/A.

3.5.3.8 Crew Equipment N/A.

3.5.4 Launch Escape System

3.5.4.1 The LES shall be capable of removing the boilerplate CSM from the space vehicle after S-IVB ignition and providing sufficient separation distance to avoid interference with the space vehicle.

3.5.4.2 N/A.

3.5.5 Adapter

3.5.5.1 General No change.

3.5.5.2 Access No change.

3.5.5.3 Deployment The Adapter shall be designed to permit the boilerplate CSM to separate from the Adapter and LEM using the LES. The Adapter design shall also permit the LEM to be separated from the Adapter without aid from the CSM. The Adapter shall not interfere with launch vehicle or spacecraft communications.

3.5.5.4 Television Television cameras as specified in 3.3.5.2.5 of this appendix shall be capable of providing television coverage of the separation of the LEM from the S-IVB/IU.

3.5.6 Extravehicular Mobility Unit N/A.

3.5.7 Scientific Payload The spacecraft shall be capable of supporting the in-flight experiments identified in Apollo Flight Mission Assignments, M-D MA 500-11.

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3.5.8 Flight Crew Training Equipment N/A.

3.6 Launch Area Only the requirements which are identified with LC 37B and the Direct Launch Support Facilities are applicable with the following exceptions:

3.6.3 Launch Complexes 34 and 37B Launch of manned Apollo Saturn IB space vehicles shall not be a requirement for this mission.

3.6.3.1 Launch Pad and Umbilical Tower (c) N/A. See 3.1.1.1 (AS-206).

3.6.5.1 Operations and Checkout Building (e) Monitoring astronaut performance shall not be a requirement for this mission.

3.7 Manned Space Flight Network

3.7.1 General No change.

3.7.2 Functional Capability

3.7.2.1 Voice Communications The voice communications subsystem shall enable:

(a) Simulated voice communications from the LEM to the MCC.

(b) Duplex, 4-wire voice communications between MSFN stations and the MCC.

3.7.2.2 Telemetry The telemetry subsystem shall be able to receive:

(a) High or low bit rate operational telemetry from the LEM.

(b) Operational telemetry from each stage of the launch vehicle and the IU simultaneously with (a).

(c) Engineering data from the space vehicle simultaneously with (a) and (b).

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3.7.2.3 Tracking The tracking subsystem shall be able to:

(a) Track in angle, range and range rate the transponders in the launch vehicle during the launch phase.

(b) Track in angle and range the radar transponders in the IU and the LEM during flight.

(c) Track in angle, range and range rate the transponder in the LEM during flight.

(d) "Skin" track the space vehicle in Earth orbit.

(e) Provide sampled tracking data for transmission to the MCC, and where required, for on-site computation.

3.7.2.4 Digital Command Communications The Digital Command Communications Subsystem (DCCS) shall be able to:

(a) Transmit up-data sequentially to the LEM and the IU.

(b) Monitor and verify the transmission of up-data to the space vehicle.

(c) Receive from the telemetry subsystem verification of accurate receipt of up-data by the LEM and the IU.

(d) Transmit to the MCC verification signals received from the LEM and the IU.

(e) Be controlled by the display and control subsystem at the site or remotely from the MCC.

3.7.2.5 Television The television subsystem shall be able to receive and record television transmission from the IU.

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3.7.2.6 Display and Control No change except the CSM reference is not applicable.

3.7.2.7 Data Processing No change.

3.7.2.8 Timing No change.

3.7.3 Coverage Capability The MSFN station in the launch area shall be able to support the prelaunch checkout of the space vehicle on the launch pad.

The MSFN shall provide the coverage capabilities for the:

(a) LEM as specified in Table 3.7-2 (206) of this appendix.

(b) Saturn IB launch vehicle as specified in Table 3.7-4 (206) of this appendix.

3.7.4 Performance No change except the MSFN shall operate with the space vehicle subsystems as specified in 3.3.5 and 3.5.3.3 of this appendix.

3.8 Mission Control Center No change except delete 3.8.1 (d).

4.0 Quality Assurance No change.

APPENDIX 206

TABLE 3.3 - 1

SATURN IB LAUNCH VEHICLE COMMUNICATION AND TRACKING REQUIREMENTS

APOLLO-SATURN 206

STAGE / SUBSYSTEM	EQUIPMENT IMPLEMENTATION	NUMBER OF UNITS	OPERATING FREQUENCY TRANSMIT	OPERATING FREQUENCY RECEIVE	ANTENNA SUBSYSTEM	MODULATION CHARACTERISTICS	REMARKS
S-IB							
TELEMETRY	PCM/FM TELEMETER	ONE	225-260 Mc		OMNI-DIRECTIONAL	PCM/FM	• SEE NOTES 1, 2 AND 3 • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND
	FM/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF S-IB PCM/FM TELEMETER	FM/FM	• SEE NOTES 1 AND 4
	PAM/FM/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF S-IB PCM/FM TELEMETER	PAM/FM/FM	• SEE NOTES 1 AND 4
	SS/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF S-IB PCM/FM TELEMETER	SS/FM	• SEE NOTE 4
COMMAND DESTRUCT	RECEIVER AND DECODER	TWO		400-450 Mc	OMNI-DIRECTIONAL		• THIS SYSTEM SHALL BE COMPATIBLE WITH RANGE SAFETY COMMAND TRANSMITTERS INSTALLED AT STATIONS OF THE ETR.
TRACKING	ODOP TRANSPONDER	ONE	UHF	UHF	FIXED DIRECTIONAL		
S-IVB							
TELEMETRY	PCM/FM TELEMETER	ONE	225-260 Mc		OMNI-DIRECTIONAL	PCM/FM	• SEE NOTES 1, 2 AND 3 • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND
	FM/FM TELEMETER [6]	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF S-IVB PCM/FM TELEMETER	FM/FM	• SEE NOTES 1 AND 4
	PAM/FM/FM TELEMETER	TWO	225-260 Mc		SEE NOTE 5	PAM/FM/FM	• SEE NOTES 1 AND 4
	SS/FM TELEMETER	ONE	225-260 Mc		SEE NOTE 5	SS/FM	• SEE NOTE 4
COMMAND DESTRUCT	RECEIVER AND DECODER	TWO		400-450 Mc	OMNI-DIRECTIONAL		• THIS SYSTEM SHALL BE COMPATIBLE WITH RANGE SAFETY COMMAND TRANSMITTERS INSTALLED AT STATIONS OF THE ETR.
INSTRUMENT UNIT							
TELEMETRY	PCM/FM TELEMETER	ONE	225-260 Mc		OMNI-DIRECTIONAL	PCM/FM	• SEE NOTES 1, 2 AND 3 • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND • BIT STREAM SHALL CONTAIN ALL S-IVB/IU MISSION CONTROL DATA
	PCM/FM TELEMETER	ONE	2100-2300 Mc			PCM/FM	• SEE NOTES 1, 2 AND 3 • EXPERIMENTAL SYSTEM • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND • BIT STREAM SHALL BE IDENTICAL WITH IU VHF PCM/FM TELEMETER
	FM/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF IU VHF PCM/FM TELEMETER	FM/FM	• SEE NOTES 1 AND 4
	PAM/FM/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF IU VHF PCM/FM TELEMETER	PAM/FM/FM	• SEE NOTES 1 AND 4
	SS/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF IU VHF PCM/FM TELEMETER	SS/FM	• SEE NOTE 4
UP-DATA	RECEIVER AND DECODER	ONE		400-450 Mc	OMNI-DIRECTIONAL	PSK/FM	• SUBCODED 5-BIT WORDS AT 1000 BITS/SECOND • THE UP-DATA SUBSYSTEM SHALL BE DESIGNED IN CONJUNCTION WITH STATIONS OF THE MSFN SUCH THAT NO MORE THAN ONE CORRECT MESSAGE SHALL BE REJECTED PER 1000 CORRECT MESSAGES AND THAT NO MORE THAN ONE PER 10^{8} INCORRECT MESSAGES SHALL BE ACCEPTED.
TRACKING	C-BAND RADAR TRANSPONDER	ONE	C-BAND	C-BAND	OMNI-DIRECTIONAL	PULSE	• UTILIZES CODING DIFFERENT FROM C-BAND RADAR TRANSPONDERS ON SPACECRAFT
	AZUSA TRANSPONDER	ONE	C-BAND	C-BAND	OMNI-DIRECTIONAL	FM	
TELEVISION	TELEVISION TRANSMITTER	ONE	1700-1730 Mc			FM	

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NOTES:

1 THIS TELEMETRY SUBSYSTEM SHALL BE COMPATIBLE WITH THE INTER RANGE INSTRUMENTATION GROUP STANDARDS (IRIG DOCUMENT NO. 106-60. "TELEMETRY STANDARDS REVISED 1962")

2. ALL PCM TELEMETRY SUBSYSTEMS SHALL BE DESIGNED TO PROVIDE AN ERROR RATE NOT EXCEEDING ONE BIT IN 10^{6} BITS FOR TRANSMISSIONS TO THE MSFN AS MEASURED FROM LAUNCH VEHICLE ENCODER TO EARTH-BASED DECODER.

3. THIS PCM TELEMETRY SUBSYSTEM SHALL BE CAPABLE OF TRANSMITTING THE PCM BIT STREAM REQUIRED FOR REAL-TIME USE VIA COAXIAL CABLE TO THE CHECKOUT FACILITY IN THE MILA PRIOR TO LIFT-OFF AND VIA AN RF LINK PRIOR TO AND AFTER LIFT-OFF.

4. THIS TELEMETRY SUBSYSTEM SHALL TRANSMIT DATA REQUIRED ONLY FOR POST-MISSION ANALYSIS VIA AN RF LINK.

5. UP TO 4 VHF STAGE TELEMETERS SHALL BE MULTIPLEXED ON A COMMON ANTENNA SUB-SYSTEM. WHEN MORE THAN 4 VHF STAGE TELEMETERS ARE CARRIED, A SECOND OMNI-DIRECTIONAL ANTENNA SUBSYSTEM SHALL BE PROVIDED.

6. NOT PRESENTLY SCHEDULED FOR OPERATIONAL SATURN IB LAUNCH VEHICLES. HOWEVER, PROVISIONS TO CARRY THIS TELEMETER SHALL BE INCORPORATED ON ALL SATURN IB LAUNCH VEHICLES THROUGH AS-207.

EQUIPMENT/FUNCTION THIS FLIGHT	EQUIPMENT/FUNCTION OPERATIONAL VEHICLE	CODING
REQUIRED	REQUIRED	
REQUIRED	NOT REQUIRED	
NOT REQUIRED	REQUIRED	
NOT REQUIRED	NOT REQUIRED	

TABLE 3.3-1
APOLLO SATURN 206

APPENDIX 206
TABLE 3. 5 - 4A
LEM COMMUNICATIONS AND TRACKING REQUIREMENTS
APOLLO-SATURN 206

SUBSYSTEM		EQUIPMENT IMPLEMENTATION	NUMBER OF UNITS	OPERATING FREQUENCY TRANSMIT	OPERATING FREQUENCY RECEIVE	ANTENNA SUBSYSTEM	MODULATION CHARACTERISTICS	REMARKS
VOICE COMMUNICATIONS (SEE NOTE 1)	WITH MSFN	UNIFIED S-BAND SYSTEM						• SEE TABLE 3.5-4B FOR REQUIREMENTS
	WITH MSFN	VHF TRANSCEIVER #1		VHF				• UTILIZED FOR VOICE TRANSMISSION SIMULATION DURING R & D FLIGHT PROGRAM • SEE "VOICE COMMUNICATIONS WITH CSM"
	WITH MSFN	VHF TRANSCEIVER #2		VHF	VHF			• UTILIZED FOR VOICE AND DATA TRANSMISSION DURING R & D FLIGHT PROGRAM • SEE "VOICE COMMUNICATIONS WITH CSM"
	WITH CSM	VHF TRANSCEIVER #1	ONE	VHF	VHF	OMNI-DIRECTIONAL	DSBAM TRANSMIT DSBAM RECEIVE	• PRIMARY VOICE COMMUNICATIONS CHANNEL WITH CSM VIA SIMPLEX MODE • TRANSMITTER UTILIZED FOR DUPLEX VOICE COMMUNICATIONS WITH EVA • TRANSCEIVER UTILIZED IN BACK-UP MODE FOR SIMPLEX VOICE COMMUNICATIONS WITH EVA
	WITH CSM	VHF TRANSCEIVER #2	ONE	VHF	VHF	MULTIPLEXED WITH TRANSCEIVER #1	DSBAM TRANSMIT DSBAM RECEIVE	• BACK-UP VOICE COMMUNICATIONS CHANNEL WITH CSM VIA SIMPLEX MODE • TRANSMITS LEM PCM/AM DATA TO CSM • RECEIVER UTILIZED FOR DUPLEX VOICE COMMUNICATIONS WITH EVA • RECEIVES EVA BIOMEDICAL DATA SIMULTANEOUSLY WITH EVA VOICE • TRANSCEIVER UTILIZED IN BACK-UP MODE FOR SIMPLEX VOICE COMMUNICATIONS WITH EVA
	WITH EVA	VHF TRANSCEIVER #1		VHF	VHF			• SEE "VOICE COMMUNICATIONS WITH CSM"
	WITH EVA	VHF TRANSCEIVER #2		VHF	VHF			• SEE "VOICE COMMUNICATIONS WITH CSM"
KEYING COMMUNICATIONS	TO MSFN	UNIFIED S-BAND SYSTEM						• SEE TABLE 3.5-4B FOR REQUIREMENTS
TELEMETRY	TO MSFN	UNIFIED S-BAND SYSTEM						• SEE TABLE 3.5-4B FOR REQUIREMENTS
	TO MFSN	VHF TELEMETER	ONE	225-260 Mc		R & D OMNI-DIRECTIONAL SUBSYSTEM ON LEM AND ON ADAPTER	PAM/FM/FM	• SEE NOTE 3
	TO MSFN	VHF TELEMETER	ONE	225-260 Mc		MULTIPLEXED ON VHF R & D TELEMETRY ANTENNA SUB-SYSTEM	PAM/FM/FM	• SEE NOTE 3
	TO MSFN	VHF TELEMETER	ONE	225-260 Mc		MULTIPLEXED ON VHF R & D TELEMETRY ANTENNA SUB-SYSTEM	PAM/FM/FM	• SEE NOTE 3
	TO MSFN	VHF TELEMETER	ONE	225-260 Mc		MULTIPLEXED ON VHF R & D TELEMETRY ANTENNA SUB-SYSTEM	FM/FM	• CONSTANT BANDWIDTH SYSTEM
	TO MSFN	VHF TELEMETER	ONE	225-260 Mc		MULTIPLEXED ON VHF R & D TELEMETRY ANTENNA SUB-SYSTEM	PCM/FM	• SEE NOTES 2, 3, AND 4 • REDUNDANT WITH UNIFIED S-BAND SYSTEM PCM LINK
	TO MSFN	VHF TRANSCEIVER #2		VHF				• UTILIZED FOR DATA TRANSMISSION SIMULATION DURING R & D PROGRAM • SEE "VOICE COMMUNICATIONS WITH CSM"
	TO CSM	VHF TRANSCEIVER #2		VHF			PCM/AM	• SEE NOTE 5 • PCM BIT RATE OF 1.6 KILOBITS/SECOND • SEE "VOICE COMMUNICATIONS WITH CSM"
	FROM EVA	VHF TRANSCEIVER #2			VHF		FM/AM	• SEE "VOICE COMMUNICATIONS WITH CSM"
TAPE PLAYBACK	TO MSFN							• NOT APPLICABLE
TELEVISION	TO MSFN	UNIFIED S-BAND SYSTEM						• SEE TABLE 3.5-4B FOR REQUIREMENTS
UP - DATA (SEE NOTE 6)	FROM MSFN	RECEIVER AND DECODER	ONE		400-450 Mc	UTILIZES VHF R & D TELEMETRY ANTENNA SUBSYSTEM	PSK/FM	• UTILIZED ONLY DURING R & D FLIGHT PROGRAM
TRACKING AID	TO MSFN	UNIFIED S-BAND SYSTEM						• SEE TABLE 3.5-4B FOR REQUIREMENTS
	TO MSFN	C-BAND RADAR TRANSPONDER	TWO	C-BAND	C-BAND	OMNI-DIRECTIONAL	PULSE	• SAME CODING IS UTILIZED FOR BOTH TRANSPONDERS BUT CODING DIFFERS FROM THAT USED BY CSM AND LAUNCH VEHICLE
TRACKING	OF CSM	RENDEZVOUS RADAR	TWO	X-BAND	X-BAND	DIRECTIONAL	PM TRANSMIT PM RECEIVE	• THREE-TONE RANGE CODE AND CARRIER COHERENT TURN-AROUND • ACCURACY: (a) VELOCITY 1/4% OR 1 fps (b) RANGE 1% OR 20 feet (c) ANGLE 8mr bias 2mr random • ALSO USED FOR TRACKING OF TRACKING AID ON LUNAR SURFACE
	OF TRACKING AID ON LUNAR SURFACE	RENDEZVOUS RADAR		X-BAND	X-BAND			• SEE "TRACKING OF CSM"
	OF LUNAR SURFACE	LANDING RADAR	ONE	X-BAND	X-BAND	DIRECTIONAL	CW AND FM/CW TRANSMIT	• ACCURACY: (a) VELOCITY 1% OR 1 fps (b) RANGE 1% OR 5 feet

NOTES:

1. THE MINIMUM WORD INTELLIGIBILITY SHALL BE 90% FOR NORMAL VOICE COMMUNICATIONS AND 70% FOR BACK-UP COMMUNICATIONS AS MEASURED BY USER PERSONNEL UNDER SIMULATED OPERATING CONDITIONS UTILIZING THE AMERICAN STANDARD METHOD FOR MEASUREMENT OF MONOSYLLABIC WORD INTELLIGIBILITY DATED MAY 25, 1960.

2. THE TELEMETRY SUBSYSTEM SHALL BE DESIGNED TO PROVIDE AN ERROR RATE NOT EXCEEDING ONE BIT IN 10^6 BITS FOR PCM TELEMETRY TRANSMISSIONS TO STATIONS OF THE MSFN AS MEASURED FROM LEM ENCODER TO MSFN DECODER.

3. THE TELEMETRY SUBSYSTEMS SHALL BE COMPATIBLE WITH THE INTER RANGE INSTRUMENTATION GROUP STANDARDS (IRIG DOCUMENT NO. 106-60 "TELEMETRY STANDARDS REVISED 1962") APPROPRIATE TO THE RESPECTIVE TELEMETRY SUBSYSTEMS.

4. THIS PCM TELEMETRY SUBSYSTEM SHALL BE CAPABLE OF TRANSMITTING THE PCM BIT STREAM REQUIRED FOR REAL-TIME USE VIA COAXIAL CABLE TO THE CHECKOUT FACILITY IN THE MILA PRIOR TO LIFT-OFF AND VIA AN RF LINK AFTER ADAPTER JETTISON.

5. THE TELEMETRY SUBSYSTEM SHALL BE DESIGNED TO PROVIDE AN ERROR RATE NOT EXCEEDING ONE BIT IN 10^6 BITS FOR PCM TELEMETRY TRANSMISSIONS TO THE CSM AS MEASURED FROM LEM ENCODER TO CSM RECORDER.

6. NO MORE THAN ONE CORRECT MESSAGE SHALL BE REJECTED PER 1000 CORRECT MESSAGES AND THAT NO MORE THAN ONE PER 10^9 INCORRECT MESSAGES SHALL BE ACCEPTED.

LEGEND

EQUIPMENT/FUNCTION THIS FLIGHT	EQUIPMENT/FUNCTION LUNAR MISSION	CODING
REQUIRED	REQUIRED	(blank)
REQUIRED	NOT REQUIRED	(hatched)
NOT REQUIRED	REQUIRED	(dashed outline)
NOT REQUIRED	NOT REQUIRED	(cross-hatched)

3/1/66

TABLE 3. 5 - 4A
APOLLO - SATURN 206

APPENDIX 206
TABLE 3. 5 - 4A
LEM COMMUNICATIONS AND TRACKING REQUIREMENTS
APOLLO-SATURN 206

SUBSYSTEM	EQUIPMENT IMPLEMENTATION	NUMBER OF UNITS	OPERATING FREQUENCY TRANSMIT	OPERATING FREQUENCY RECEIVE	ANTENNA SUBSYSTEM	MODULATION CHARACTERISTICS	REMARKS
VOICE COMMUNICATIONS (SEE NOTE 1) WITH MSFN	UNIFIED S-BAND SYSTEM						● SEE TABLE 3.5-4B FOR REQUIREMENTS
WITH MSFN	VHF TRANSCEIVER #1		VHF				● UTILIZED FOR VOICE TRANSMISSION SIMULATION DURING R & D FLIGHT PROGRAM ● SEE "VOICE COMMUNICATIONS WITH CSM"
WITH MSFN	VHF TRANSCEIVER #2		VHF	VHF			● UTILIZED FOR VOICE AND DATA TRANSMISSION DURING R & D FLIGHT PROGRAM ● SEE "VOICE COMMUNICATIONS WITH CSM"
WITH CSM	VHF TRANSCEIVER #1	ONE	VHF	VHF	OMNI-DIRECTIONAL	DSBAM TRANSMIT DSBAM RECEIVE	● PRIMARY VOICE COMMUNICATIONS CHANNEL WITH CSM VIA SIMPLEX MODE ● TRANSMITTER UTILIZED FOR DUPLEX VOICE COMMUNICATIONS WITH EVA ● TRANSCEIVER UTILIZED IN BACK-UP MODE FOR SIMPLEX VOICE COMMUNICATIONS WITH EVA
WITH CSM	VHF TRANSCEIVER #2	ONE	VHF	VHF	MULTIPLEXED WITH TRANSCEIVER #1	DSBAM TRANSMIT DSBAM RECEIVE	● BACK-UP VOICE COMMUNICATIONS CHANNEL WITH CSM VIA SIMPLEX MODE ● TRANSMITS LEM PCM/AM DATA TO CSM ● RECEIVER UTILIZED FOR DUPLEX VOICE COMMUNICATIONS WITH EVA ● RECEIVES EVA BIOMEDICAL DATA SIMULTANEOUSLY WITH EVA VOICE ● TRANSCEIVER UTILIZED IN BACK-UP MODE FOR SIMPLEX VOICE COMMUNICATIONS WITH EVA
WITH EVA	VHF TRANSCEIVER #1		VHF	VHF			● SEE "VOICE COMMUNICATIONS WITH CSM"
WITH EVA	VHF TRANSCEIVER #2		VHF	VHF			● SEE "VOICE COMMUNICATIONS WITH CSM"
KEYING COMMUNICATIONS TO MSFN	UNIFIED S-BAND SYSTEM						● SEE TABLE 3.5-4B FOR REQUIREMENTS
TELEMETRY TO MSFN	UNIFIED S-BAND SYSTEM						● SEE TABLE 3.5-4B FOR REQUIREMENTS
TO MFSN	VHF TELEMETER	ONE	225-260 Mc		R & D OMNI-DIRECTIONAL SUBSYSTEM ON LEM AND ON ADAPTER	PAM/FM/FM	● SEE NOTE 3
TO MSFN	VHF TELEMETER	ONE	225-260 Mc		MULTIPLEXED ON VHF R & D TELEMETRY ANTENNA SUB-SYSTEM	PAM/FM/FM	● SEE NOTE 3
TO MSFN	VHF TELEMETER	ONE	225-260 Mc		MULTIPLEXED ON VHF R & D TELEMETRY ANTENNA SUB-SYSTEM	PAM/FM/FM	● SEE NOTE 3
TO MSFN	VHF TELEMETER	ONE	225-260 Mc		MULTIPLEXED ON VHF R & D TELEMETRY ANTENNA SUB-SYSTEM	FM/FM	● CONSTANT BANDWIDTH SYSTEM
TO MSFN	VHF TELEMETER	ONE	225-260 Mc		MULTIPLEXED ON VHF R & D TELEMETRY ANTENNA SUB-SYSTEM	PCM/FM	● SEE NOTES 2, 3, AND 4 ● REDUNDANT WITH UNIFIED S-BAND SYSTEM PCM LINK
TO MSFN	VHF TRANSCEIVER #2		VHF				● UTILIZED FOR DATA TRANSMISSION SIMULATION DURING R & D PROGRAM ● SEE "VOICE COMMUNICATIONS WITH CSM"
TO CSM	VHF TRANSCEIVER #2		VHF			PCM/AM	● SEE NOTE 5 ● PCM BIT RATE OF 1.6 KILOBITS/SECOND ● SEE "VOICE COMMUNICATIONS WITH CSM"
FROM EVA	VHF TRANSCEIVER #2			VHF		FM/AM	● SEE "VOICE COMMUNICATIONS WITH CSM"
TAPE PLAYBACK TO MSFN							● NOT APPLICABLE
TELEVISION TO MSFN	UNIFIED S-BAND SYSTEM						● SEE TABLE 3.5-4B FOR REQUIREMENTS
UP - DATA (SEE NOTE 6) FROM MSFN	RECEIVER AND DECODER	ONE		400-450 Mc	UTILIZES VHF R & D TELEMETRY ANTENNA SUBSYSTEM	PSK/FM	● UTILIZED ONLY DURING R & D FLIGHT PROGRAM
TRACKING AID TO MSFN	UNIFIED S-BAND SYSTEM						● SEE TABLE 3.5-4B FOR REQUIREMENTS
TO MSFN	C-BAND RADAR TRANSPONDER	TWO	C-BAND	C-BAND	OMNI-DIRECTIONAL	PULSE	● SAME CODING IS UTILIZED FOR BOTH TRANSPONDERS BUT CODING DIFFERS FROM THAT USED BY CSM AND LAUNCH VEHICLE
TRACKING OF CSM	RENDEZVOUS RADAR	TWO	X-BAND	X-BAND	DIRECTIONAL	PM TRANSMIT PM RECEIVE	● THREE-TONE RANGE CODE AND CARRIER COHERENT TURN-AROUND ● ACCURACY: (a) VELOCITY 1/4% OR 1 fps (b) RANGE 1% OR 20 feet (c) ANGLE 8mr bias 2mr random ● ALSO USED FOR TRACKING OF TRACKING AID ON LUNAR SURFACE
OF TRACKING AID ON LUNAR SURFACE	RENDEZVOUS RADAR		X-BAND	X-BAND			● SEE "TRACKING OF CSM"
OF LUNAR SURFACE	LANDING RADAR	ONE	X-BAND	X-BAND	DIRECTIONAL	CW AND FM/CW TRANSMIT	● ACCURACY: (a) VELOCITY 1% OR 1 fps (b) RANGE 1% OR 5 feet

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NOTES:

1. THE MINIMUM WORD INTELLIGIBILITY SHALL BE 90% FOR NORMAL VOICE COMMUNICATIONS AND 70% FOR BACK-UP COMMUNICATIONS AS MEASURED BY USER PERSONNEL UNDER SIMULATED OPERATING CONDITIONS UTILIZING THE AMERICAN STANDARD METHOD FOR MEASUREMENT OF MONOSYLLABIC WORD INTELLIGIBILITY DATED MAY 25, 1960.

2. THE TELEMETRY SUBSYSTEM SHALL BE DESIGNED TO PROVIDE AN ERROR RATE NOT EXCEEDING ONE BIT IN 10^6 BITS FOR PCM TELEMETRY TRANSMISSIONS TO STATIONS OF THE MSFN AS MEASURED FROM LEM ENCODER TO MSFN DECODER.

3. THE TELEMETRY SUBSYSTEMS SHALL BE COMPATIBLE WITH THE INTER RANGE INSTRUMENTATION GROUP STANDARDS (IRIG DOCUMENT NO. 106-60 "TELEMETRY STANDARDS REVISED 1962") APPROPRIATE TO THE RESPECTIVE TELEMETRY SUBSYSTEMS.

4. THIS PCM TELEMETRY SUBSYSTEM SHALL BE CAPABLE OF TRANSMITTING THE PCM BIT STREAM REQUIRED FOR REAL-TIME USE VIA COAXIAL CABLE TO THE CHECKOUT FACILITY IN THE MILA PRIOR TO LIFT-OFF AND VIA AN RF LINK AFTER ADAPTER JETTISON.

5. THE TELEMETRY SUBSYSTEM SHALL BE DESIGNED TO PROVIDE AN ERROR RATE NOT EXCEEDING ONE BIT IN 10^6 BITS FOR PCM TELEMETRY TRANSMISSIONS TO THE CSM AS MEASURED FROM LEM ENCODER TO CSM RECORDER.

6. NO MORE THAN ONE CORRECT MESSAGE SHALL BE REJECTED PER 1000 CORRECT MESSAGES AND THAT NO MORE THAN ONE PER 10^9 INCORRECT MESSAGES SHALL BE ACCEPTED.

LEGEND

EQUIPMENT/FUNCTION THIS FLIGHT	EQUIPMENT/FUNCTION LUNAR MISSION	CODING
REQUIRED	REQUIRED	
REQUIRED	NOT REQUIRED	
NOT REQUIRED	REQUIRED	
NOT REQUIRED	NOT REQUIRED	

APPENDIX 206
TABLE 3.7-2
REQUIRED LEM COVERAGE
APOLLO-SATURN 206

SUBSYSTEM \ PHASE	S-IB BURN	S-IVB	END OF S-IVB BURN +3 MINUTES	COAST IN EARTH ORBIT [1]	S/C - LV SEPARATION	-2 MINUTES TO DPS BURNS	DPS BURNS	LEM COAST PERIODS	-2 MINUTES TO APS BURNS	APS BURNS
VHF										
SIMULATED VOICE	NOT REQUIRED	NOT REQUIRED	NOT REQUIRED	PARTIAL COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	PARTIAL COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE
TELEMETRY [2]	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	PARTIAL COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	PARTIAL COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE
UHF										
UP-DATA	NOT REQUIRED	NOT REQUIRED	CONTINUOUS COVERAGE	PARTIAL COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	PARTIAL COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE
C-BAND										
TRACKING [2,3]	NOT REQUIRED	NOT REQUIRED	NOT REQUIRED	NOT REQUIRED	PARTIAL COVERAGE	NOT REQUIRED	NOT REQUIRED	PARTIAL COVERAGE	NOT REQUIRED	NOT REQUIRED
S-BAND										
SIMULATED VOICE	NOT REQUIRED	NOT REQUIRED	NOT REQUIRED	NOT REQUIRED	PARTIAL COVERAGE	PARTIAL COVERAGE	PARTIAL COVERAGE	PARTIAL COVERAGE	PARTIAL COVERAGE	PARTIAL COVERAGE
TELEMETRY [2]	NOT REQUIRED	NOT REQUIRED	NOT REQUIRED	NOT REQUIRED	PARTIAL COVERAGE	PARTIAL COVERAGE	PARTIAL COVERAGE	PARTIAL COVERAGE	PARTIAL COVERAGE	PARTIAL COVERAGE
TRACKING [2,3]	NOT REQUIRED	NOT REQUIRED	NOT REQUIRED	NOT REQUIRED	PARTIAL COVERAGE	PARTIAL COVERAGE	PARTIAL COVERAGE	PARTIAL COVERAGE	PARTIAL COVERAGE	PARTIAL COVERAGE

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1. GAP BETWEEN CONTACTS SHALL BE NO GREATER THAN 1/2 ORBIT. CONTACTS SHALL BE AT LEAST 3 MINUTES LONG.

2. VHF TELEMETRY AND C-BAND TRACKING ARE THE PRIMARY OPERATIONAL SYSTEMS.

3. S-BAND TRACKING SHALL PROVIDE DIRECT MEASUREMENT OF LEM ANGLE, RANGE AND RANGE RATE. C-BAND TRACKING SHALL PROVIDE DIRECT MEASUREMENT OF LEM ANGLE AND RANGE.

PARTIAL COVERAGE

CONTINUOUS COVERAGE

NOT REQUIRED

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TABLE 3.7-4

REQUIRED SATURN IB LAUNCH VEHICLE COVERAGE

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SUBSYSTEM \ PHASE	S-IB BURN	S-IVB BURN	END OF S-IVB BURN +3 MINUTES	COAST IN EARTH ORBIT [4]	S-IVB/IU CHECKOUT IN EARTH ORBIT [5]	SPACECRAFT SEPARATION	EARTH ORBIT COAST AFTER SPACECRAFT SEPARATION
VHF TELEMETRY							
S-IB	CONTINUOUS COVERAGE [1]						
S-IVB	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	PARTIAL COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	PARTIAL COVERAGE
IU	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	PARTIAL COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	PARTIAL COVERAGE
TELEVISION							
IU						CONTINUOUS COVERAGE	
COMMAND DESTRUCT							
S-IB	CONTINUOUS COVERAGE [2]						
S-IVB	CONTINUOUS COVERAGE	PARTIAL COVERAGE [2]					
UHF UP-DATA							
IU	PARTIAL COVERAGE	PARTIAL COVERAGE	CONTINUOUS COVERAGE	PARTIAL COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	PARTIAL COVERAGE
TRACKING							
C-BAND	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE [3]	CONTINUOUS COVERAGE	PARTIAL COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	PARTIAL COVERAGE
ODOP	PARTIAL COVERAGE [3]						
AZUSA	PARTIAL COVERAGE	PARTIAL COVERAGE [3]					

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1 COVERAGE SHALL CONTINUE FOR AT LEAST ONE MINUTE AFTER THE END OF BURN.

2 CONTINUOUS COVERAGE UNTIL THE PREDICTED IMPACT POINT OF THE VEHICLE IS OUTSIDE AREAS SPECIFIED BY RANGE SAFETY.

3 TWO LAUNCH VEHICLE TRANSPONDERS SHALL BE TRACKED CONTINUOUSLY TO SATISFY RANGE SAFETY REQUIREMENTS.

4 THE GAP BETWEEN CONTACTS SHALL BE NO GREATER THAN 1/2 ORBIT. CONTACTS SHALL BE AT LEAST 3 MINUTES LONG.

5 THIS REQUIREMENT MAY BE SATISFIED DURING AN ORBITAL CONTACT.

PARTIAL COVERAGE (hatched) CONTINUOUS COVERAGE (shaded) NOT REQUIRED (blank)

Apollo Saturn Mission 207

1.0 Scope This appendix to the Apollo Program Specification identifies the performance, design and test requirements which apply to the Program elements to be utilized for Apollo Saturn Mission 207 (AS-207). These requirements are presented in this appendix as deviations to the requirements specified for equipment in the body of the specification. Unless otherwise noted, the paragraphs in this appendix replace in their entirety the identically numbered paragraphs in the body of the specification.

1.1 Applicability No change.[1]

1.2 Change Approval No change.

2.0 Applicable Documents No change.

3.0 Requirements

3.1 Performance

3.1.1 Characteristics

3.1.1.1 General Add: To the extent practicable, the spacecraft used on AS-207 shall be of the same design as the lunar landing configuration.

3.1.1.2 Mission Performance

3.1.1.2.1 Mission Mode This Apollo test mission shall be performed primarily in Earth orbit. The spacecraft, which includes a

(1) The phrase "no change" is used after a section heading throughout this appendix to mean that the requirement in the body of the specification applies to this mission without change.

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manned CM, SM and a LEM, shall be launched from the Cape Kennedy launch area (LC 37B) into the desired trajectory by a Saturn IB launch vehicle consisting of an S-IB first stage, an S-IVB (Saturn IB version) second stage and an IU (Saturn IB version). After CSM/LEM separation from the remainder of the space vehicle, the spacecraft propulsion systems shall be used to maneuver in Earth orbit. After CSM and LEM maneuvers, involving the LEM manned and unmanned, SM propulsion will be used to reduce the spacecraft velocity sufficiently for entry. The SM shall be jettisoned prior to entry of the CM into the Earth's atmosphere. The CM shall be slowed to a safe landing by aerodynamic braking and, during the final phase of the landing sequence, by parachute.

3.1.1.2.2 Mission Command Add: A Mission Control Programmer shall be provided on board the LEM which, in conjunction with the LEM guidance computer shall provide LEM commands as necessary for accomplishment of the mission. The Mission Control Programmer shall be capable, independent of the LEM guidance computer, of receiving signals from ground-based personnel as a backup.

3.1.1.2.3 Payload The payload for this mission shall be a manned spacecraft. The objectives of this mission shall include those identified in Apollo Flight Mission Assignments, M-D MA 500-11.

3.1.1.2.4 Earth Launch Launch capability shall be provided to permit an initial flight azimuth of 072°.

3.1.1.2.5 Earth Parking Orbit The capability shall be provided to place the spacecraft into an elliptical orbit with a nominal apogee of 107 nm and a nominal perigee of 81 nm. CSM and LEM propulsion systems shall provide for subsequent Earth orbital maneuvers.

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3.1.1.2.6 Injection Opportunities Not Applicable. (N/A).[2]

3.1.1.2.7 Lunar Landing Accuracy N/A. See 3.1.1.1 (AS-207).

3.1.1.2.8 Lunar Exploration N/A.

3.1.1.2.9 Earth Landing The normal Earth landing mode shall be on water. The capability for water and land landing shall be as specified in 3.5.1.24.

3.1.1.2.10 Recovery No change.

3.1.2 Program Definition No change.

3.1.3 Operability

3.1.3.1 Logistics No change.

3.1.3.2 Safety No change.

3.1.3.3 Reliability

3.1.3.3.1 Equipment Reliability No change except: In Table 3.1-2 add "the success probability for the S-IB stage shall be at least 0.95." Change Note 1 to "the preflight phase begins with the decision to start countdown for launch and ends with launch".

3.1.3.3.2 Environmental Hazards Change "the lunar landing mission" to "this mission" and delete reference to the lunar surface.

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(2) The phrase "not applicable" is used after a section heading throughout this appendix to mean that the requirement in the body of the specification does not apply to this mission.

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3.1.3.3.3 Crew Safety No change.

3.1.3.3.4 System Design Policy No change.

3.1.3.3.5 Reliability Assurance No change.

3.2 Program Standards No change.

3.3 Saturn IB Launch Vehicle

3.3.1 General No change except that the launch vehicle control weights shall be as specified for AS-207 in Table 10.1-1, Appendix 10.1.

3.3.1.1 Payload The launch vehicle shall provide the payload capability specified for AS-207 in Table 10.1-1, Appendix 10.1.

3.3.1.2 Standby Time No change.

3.3.1.3 Prelaunch Checkout No change.

3.3.1.4 In-Flight Performance Evaluation No change.

3.3.1.5 Emergency Detection Subsystem No change.

3.3.1.6 Instrumentation No change.

3.3.1.7 Command Destruct No change.

3.3.1.8 Electrical Power No change.

3.3.2 Structure No change.

3.3.2.1 Prelaunch Environment No change.

3.3.2.2 Launch and Flight Environment No change.

3.3.3 Propulsion No change.

3.3.4 Launch Vehicle Guidance, Navigation and Control No change.

3.3.5 Saturn IB Launch Vehicle Communications and Tracking No change.

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3.4 Saturn V Launch Vehicle N/A.

3.5 Spacecraft

3.5.1 General No change except that spacecraft control weights shall be as specified for AS-207 in Table 10.1-3, Appendix 10.1. The spacecraft subsystems shall be capable of accomplishing a 3-day mission at the design performance levels specified herein. Delete reference to ΔV budget.

3.5.1.1 Prelaunch Environment No change.

3.5.1.2 Prelaunch Checkout No change.

3.5.1.3 In-Flight Performance Evaluation No change.

3.5.1.4 Standby Time The spacecraft shall have the capability to stand by in a loaded condition, after launch vehicle propellant loading, for 10 hours and still perform the mission.

3.5.1.5 Launch and Flight Environment No change.

3.5.1.6 Earth Orbit Environment No change.

3.5.1.7 Translunar Environment N/A. See 3.1.1.1 (AS-207).

3.5.1.8 Transposition The CSM shall be capable of being repositioned from the launch configuration to the docked configuration within 4.5 hours after insertion. After transposition the spacecraft shall be capable of being separated from, and avoiding impact with, the remainder of the space vehicle during subsequent flight maneuvers.

3.5.1.9 One-Man Operation Delete reference to lunar operations.

3.5.1.10 CSM/LEM Abort No change.

3.5.1.11 Separation Time No change.

3.5.1.12 Descent Abort N/A.

3.5.1.13 Translational Range N/A.

3.5.1.14 Lunar Environment N/A. See 3.1.1.1 (AS-207).

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3.5.1.15 Lunar Landing N/A. See 3.1.1.1 (AS-207).

3.5.1.16 Lunar Operations The LEM shall be capable of accommodating the temperature of lunar day as given in 5.7 of M-DE 8020.008B.

3.5.1.17 Scientific Equipment Support See 3.5.7 (AS-207).

3.5.1.18 Sterilization No change.

3.5.1.19 Launch Platform N/A.

3.5.1.20 Ascent Stage Operations Using the LEM Ascent Propulsion Subsystem, the ascent stage shall be capable of separating from the descent stage during Earth orbit. The ascent stage shall be capable of operation independent of the descent stage for at least the time necessary to achieve the objectives specified in 3.1.1.2.3 (AS-207).

3.5.1.21 Rendezvous and Dock Change "lunar" to "Earth".

3.5.1.22 Entry The CM shall be capable of controlled flight through the Earth's atmosphere (as given in 2.5 of M-DE 8020.008B) to a preselected landing area. This shall be possible without exceeding a 10g deceleration for an Earth orbital entry. The design limit entry load for all CM systems shall be a 20g deceleration.

3.5.1.23 Aerodynamic Characteristics No change.

3.5.1.24 Landing No change.

3.5.1.25 Postlanding No change.

3.5.1.26 Recovery No change.

3.5.2 Command and Service Module

3.5.2.1 Structure No change.

3.5.2.2 CSM Propulsion

3.5.2.2.1 General No change except that ΔV numbers in Table 3.5-1 are not applicable.

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3.5.2.2.2 Command Module Reaction Control Subsystem No change.

3.5.2.2.3 Service Module Reaction Control Subsystem No change.

3.5.2.2.4 Service Module Propulsion Subsystem No change.

3.5.2.3 CSM Communications and Tracking

3.5.2.3.1 General No change.

3.5.2.3.2 Functional Capability No change.

3.5.2.3.3 Coverage Capability

3.5.2.3.3.1 CSM-MSFN The CSM Communication and Tracking System shall be able to operate with the MSFN to achieve the coverage specified in Table 3.7-1 (207) of this appendix.

3.5.2.3.3.2 CSM-LEM No change.

3.5.2.3.3.3 CSM-EVA No change.

3.5.2.3.4 Performance No change except that a C-Band radar transponder, utilizing an omnidirectional antenna subsystem and pulse modulation, shall also be carried. Interrogation coding, differing from the launch vehicle and LEM radar transponders, shall be utilized.

3.5.2.4 Electrical Power Subsystem

3.5.2.4.1 General Change "14 day" to "3 day" and change "during the translunar and lunar orbit phases" to "while docked."

3.5.2.4.2 Nominal Capacity No change.

3.5.2.4.3 Sizing No change.

3.5.2.4.4 Water and Oxygen Supply No change.

3.5.2.4.5 Pyrotechnic Firing Circuits No change.

3.5.2.4.6 Ground Support No change.

3.5.2.5 Integrated Navigation, Guidance and Control

3.5.2.5.1 General No change.

3.5.2.5.1.1 No change.

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3.5.2.5.1.2 No change.

3.5.2.5.1.3 No change.

3.5.2.5.1.4 No change.

3.5.2.5.1.5 The PNGCS shall:

(a) Delete "and lunar landmarks."

(b) No change.

(c) No change.

(d) Change "lunar" to "Earth."

(e) Change "S-IC" to "S-IB" and delete "S-II."

(f) No change.

3.5.2.5.2 Accuracy The PNGCS shall be capable of guiding the CM during entry to a preselected point of parachute deployment with a 10 nm CEP.

3.5.2.6 Display and Control Subsystem No change.

3.5.2.7 Environmental Control Subsystem No change.

3.5.2.8 Crew Equipment No change.

3.5.3 Lunar Excursion Module

3.5.3.1 Structure

3.5.3.1.1 Cabin Space No change.

3.5.3.1.2 Windows Delete: and lunar landing.

3.5.3.1.3 Ingress and Egress No change except (c) is not applicable.

3.5.3.1.4 Docking No change.

3.5.3.1.5 Thermal Requirements No change.

3.5.3.1.6 EMU Storage No change.

3.5.3.2 LEM Propulsion

3.5.3.2.1 General No change except that ΔV numbers in Table 3.5-1 are not applicable.

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3.5.3.2.2 LEM Reaction Control Subsystem The LEM RCS shall provide thrust for translation along three axes and attitude control about three axes during rendezvous, docking, descent engine and ascent engine operations. There shall be two separate, redundant subsystems. Propellant shall be transferable from the LEM ascent stage main propellant tanks to the LEM RCS engines.

3.5.3.2.3 LEM Descent Propulsion Subsystem The LEM Descent Propulsion Subsystem shall provide the propulsion necessary to support the mission objectives of 3.1.1.2.3 (AS-207).

3.5.3.2.4 LEM Ascent Propulsion Subsystem The LEM Ascent Propulsion Subsystem shall provide the propulsion necessary to support the mission objectives of 3.1.1.2.3 (AS-207). It shall be capable of providing the propulsion required to return the LEM ascent stage to the CSM.

3.5.3.3 LEM Communications and Tracking

3.5.3.3.1 General Add: (e) Up-data reception.

3.5.3.3.2 Functional Capability

3.5.3.3.2.1 Voice Communication No change.

3.5.3.3.2.2 Telemetry Add: (e) Transmit the data required for postflight analysis.

3.5.3.3.2.3 Tracking and Tracking Aid Delete (c).

3.5.3.3.2.4 Television Delete "from the lunar surface."

3.5.3.3.2.5 Up-Data The up-data subsystem shall be able to:

(a) Receive data from the MSFN.

(b) Supply up-data verification signals to the MSFN via the LEM telemetry subsystem.

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3.5.3.3.3 Coverage Capability

3.5.3.3.3.1 LEM-MSFN The LEM Communication and Tracking System shall be able to operate with the MSFN to achieve the coverage specified in Table 3.7-2 (207) of this appendix.

3.5.3.3.3.2 LEM-CSM No change.

3.5.3.3.3.3 LEM-EVA Delete reference to the lunar surface.

3.5.3.3.3.4 LEM-Lunar Surface N/A.

3.5.3.3.4 Performance The LEM Communication and Tracking System shall meet the requirements specified in Tables 3.5-4A (207) and 3.5-4B (207) of this appendix.

3.5.3.4 Electrical Power Subsystem

3.5.3.4.1 General Change 14-day mission to 3-day mission. Change "during the translunar and lunar orbit phases" to "while docked." Delete last sentence.

3.5.3.4.2 Sizing Delete: in lunar orbit.

3.5.3.4.3 Nominal Capacity No change.

3.5.3.4.4 Pyrotechnic Firing Circuits No change.

3.5.3.4.5 Ground Support No change.

3.5.3.5 Integrated Navigation, Guidance and Control System

3.5.3.5.1 General Delete last sentence. Add:

The Primary Navigation, Guidance and Control System (PNGCS) and the Stabilization and Control System (SCS) shall be used in conjunction with the Mission Control Programmer (MCP) to provide the LEM with the capability of executing unmanned flight sequences after LEM separation from the CSM, including stabilization of the LEM for re-dock with the manned CSM. The MCP and SCS shall also provide LEM control in the event of PNGCS failure.

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LEM control during unmanned operation of the LEM shall be provided by the LEM Guidance Computer in conjunction with the MCP. The guidance computer shall initiate LEM guidance and control functions. As a backup the MCP shall be able to accept certain discrete ground commands independent of the PNGCS so as to provide LEM control.

3.5.3.5.1.1 No change.

3.5.3.5.1.2 No change.

3.5.3.5.1.3 No change.

3.5.3.5.1.4 The PNGCS shall:

(a) No change.

(b) N/A. See 3.1.1.1 (AS-207).

(c) N/A. See 3.1.1.1 (AS-207).

(d) Delete "both" and "on the lunar surface."

(e) N/A. See 3.1.1.1 (AS-207).

(f) No change.

(g) No change.

(h) Provide for prelaunch alignment of the PNGCS IMU.

(i) Permit the guidance computer to accept commands and navigation data from the MSFN via the up-data link.

3.5.3.5.2 Accuracy N/A. See 3.1.1.1 (AS-207).

3.5.3.6 Display and Control (D&C) Subsystem No change.

3.5.3.7 Environmental Control Subsystem No change.

3.5.3.7.1 Extravehicular Operations The LEM ECS shall be designed to support the extravehicular operations necessary to accomplish the mission objectives of 3.1.1.2.3 (AS-207).

3.5.3.7.2 Atmospheric Supply No change.

3.5.3.7.2.1 Atmospheric Control No change.

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3.5.3.7.3 Water Management No change.

3.5.3.7.4 EMU Support The ECS shall incorporate arrangements to provide intravehicular support for two astronauts in pressurized suits for a continuous period consistent with the mission objectives of 3.1.1.2.3 (AS-207). The design shall be based on an energy expenditure not exceeding 800 BTU's/man/hour and a Respiration Quotient of 0.85.

3.5.3.8 Crew Equipment

3.5.3.8.1 General The LEM shall contain the provisions and equipment to protect and sustain the crew for the period necessary to support the mission objectives of 3.1.1.2.3 (AS-207).

3.5.3.8.2 Support and Restraint No change.

3.5.3.8.3 Illumination No change.

3.5.3.8.4 Food and Water No change.

3.5.3.8.5 Waste Management Delete: on the lunar surface.

3.5.3.8.6 Medical Supplies No change.

3.5.3.8.7 Biomedical Instrumentation No change.

3.5.4 Launch Escape System No change.

3.5.5 Adapter No change.

3.5.6 Extravehicular Mobility Unit

3.5.6.1 General Change "in 3.1.1.2.8" to "of this mission."

3.5.6.2 Extravehicular Delete "or on the lunar surface" and the reference to 5.0 of M-DE 8020.008B.

3.5.6.3 Intravehicular No change.

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3.5.7 Scientific Payload The spacecraft shall be capable of supporting the in-flight experiments identified in Apollo Flight Mission Assignments, M-D MA 500-11.

3.5.8 Flight Crew Training Equipment No change.

3.6 Launch Area The requirements of this section, which are identified with LC 37B and the Direct Launch Support Facilities, are applicable without change. All other requirements of this section are not applicable.

3.7 Manned Space Flight Network

3.7.1 General No change.

3.7.2 Functional Capability

3.7.2.1 Voice Communications No change.

3.7.2.2 Telemetry No change.

3.7.2.3 Tracking No change.

3.7.2.4 Digital Command Communications The Digital Command Communications Subsystem (DCCS) shall be able to:

(a) Transmit up-data sequentially to the CSM, LEM and the IU.

(b) No change.

(c) Receive from the telemetry subsystem verification of accurate receipt of up-data by the CSM, LEM and the IU.

(d) Transmit verification signals received from the CSM, LEM and the IU to the MCC.

(e) No change.

3.7.2.5 Television No change.

3.7.2.6 Display and Control No change.

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3.7.2.7 Data Processing No change.

3.7.2.8 Timing No change.

3.7.3 Coverage Capability The MSFN station in the launch area shall be able to support prelaunch checkout of the space vehicle on the launch pad.

The MSFN shall provide the coverage capabilities for the:

(a) CSM as specified in Table 3.7-1 (207) of this appendix.

(b) LEM as specified in Table 3.7-2 (207) of this appendix.

(c) N/A.

(d) No change.

3.7.4 Performance No change except the MSFN shall operate with the space vehicle subsystems as specified in 3.3.5, 3.5.2.3 and 3.5.3.3 of this appendix.

3.8 Mission Control Center No change.

4.0 Quality Assurance No change.

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APPENDIX 207
TABLE 3. 5 - 4A
LEM COMMUNICATIONS AND TRACKING REQUIREMENTS
APOLLO-SATURN 207

SUBSYSTEM	EQUIPMENT IMPLEMENTATION	NUMBER OF UNITS	OPERATING FREQUENCY TRANSMIT	OPERATING FREQUENCY RECEIVE	ANTENNA SUBSYSTEM	MODULATION CHARACTERISTICS	REMARKS
VOICE COMMUNICATIONS (SEE NOTE 1) WITH MSFN	UNIFIED S-BAND SYSTEM						• SEE TABLE 3.5-4B FOR REQUIREMENTS
WITH MSFN	VHF TRANSCEIVER #1		VHF				• UTILIZED FOR VOICE TRANSMISSION SIMULATION DURING R & D FLIGHT PROGRAM • SEE "VOICE COMMUNICATIONS WITH CSM"
WITH MSFN	VHF TRANSCEIVER #2		VHF	VHF			• UTILIZED FOR VOICE AND DATA TRANSMISSION DURING R & D FLIGHT PROGRAM • SEE "VOICE COMMUNICATIONS WITH CSM"
WITH CSM	VHF TRANSCEIVER #1	ONE	VHF	VHF	OMNI-DIRECTIONAL	DSBAM TRANSMIT DSBAM RECEIVE	• PRIMARY VOICE COMMUNICATIONS CHANNEL WITH CSM VIA SIMPLEX MODE • TRANSMITTER UTILIZED FOR DUPLEX VOICE COMMUNICATIONS WITH EVA • TRANSCEIVER UTILIZED IN BACK-UP MODE FOR SIMPLEX VOICE COMMUNICATIONS WITH EVA
WITH CSM	VHF TRANSCEIVER #2	ONE	VHF	VHF	MULTIPLEXED WITH TRANSCEIVER #1	DSBAM TRANSMIT DSBAM RECEIVE	• BACK-UP VOICE COMMUNICATIONS CHANNEL WITH CSM VIA SIMPLEX MODE • TRANSMITS LEM PCM/AM DATA TO CSM • RECEIVER UTILIZED FOR DUPLEX VOICE COMMUNICATIONS WITH EVA • RECEIVES EVA BIOMEDICAL DATA SIMULTANEOUSLY WITH EVA VOICE • TRANSCEIVER UTILIZED IN BACK-UP MODE FOR SIMPLEX VOICE COMMUNICATIONS WITH EVA
WITH EVA	VHF TRANSCEIVER #1		VHF	VHF			• SEE "VOICE COMMUNICATIONS WITH CSM"
WITH EVA	VHF TRANSCEIVER #2		VHF	VHF			• SEE "VOICE COMMUNICATIONS WITH CSM"
KEYING COMMUNICATIONS TO MSFN	UNIFIED S-BAND SYSTEM						• SEE TABLE 3.5-4B FOR REQUIREMENTS
TELEMETRY TO MSFN	UNIFIED S-BAND SYSTEM						• SEE TABLE 3.5-4B FOR REQUIREMENTS
TO MFSN	VHF TELEMETER	ONE	225-260 Mc		R & D OMNI-DIRECTIONAL SUBSYSTEM ON LEM AND ON ADAPTER	PAM/FM/FM	• SEE NOTE 3
TO MSFN	VHF TELEMETER	ONE	225-260 Mc		MULTIPLEXED ON VHF R & D TELEMETRY ANTENNA SUB-SYSTEM	PAM/FM/FM	• SEE NOTE 3
TO MSFN	VHF TELEMETER	ONE	225-260 Mc		MULTIPLEXED ON VHF R & D TELEMETRY ANTENNA SUB-SYSTEM	PAM/FM/FM	• SEE NOTE 3
TO MSFN	VHF TELEMETER	ONE	225-260 Mc		MULTIPLEXED ON VHF R & D TELEMETRY ANTENNA SUB-SYSTEM	FM/FM	• CONSTANT BANDWIDTH SYSTEM
TO MSFN	VHF TELEMETER	ONE	225-260 Mc		MULTIPLEXED ON VHF R & D TELEMETRY ANTENNA SUB-SYSTEM	PCM/FM	• SEE NOTES 2, 3, AND 4 • REDUNDANT WITH UNIFIED S-BAND SYSTEM PCM LINK
TO MSFN	VHF TRANSCEIVER #2		VHF				• UTILIZED FOR DATA TRANSMISSION SIMULATION DURING R & D PROGRAM • SEE "VOICE COMMUNICATIONS WITH CSM"
TO CSM	VHF TRANSCEIVER #2		VHF			PCM/AM	• SEE NOTE 5 • PCM BIT RATE OF 1.6 KILOBITS/SECOND • SEE "VOICE COMMUNICATIONS WITH CSM"
FROM EVA	VHF TRANSCEIVER #2			VHF		FM/AM	• SEE "VOICE COMMUNICATIONS WITH CSM"
TAPE PLAYBACK TO MSFN							• NOT APPLICABLE
TELEVISION TO MSFN	UNIFIED S-BAND SYSTEM						• SEE TABLE 3.5-4B FOR REQUIREMENTS
UP - DATA (SEE NOTE 6) FROM MSFN	RECEIVER AND DECODER	ONE		400-450 Mc	UTILIZES VHF R & D TELEMETRY ANTENNA SUBSYSTEM	PSK/FM	• UTILIZED ONLY DURING R & D FLIGHT PROGRAM
TRACKING AID TO MSFN	UNIFIED S-BAND SYSTEM						• SEE TABLE 3.5-4B FOR REQUIREMENTS
TO MSFN	C-BAND RADAR TRANSPONDER	TWO	C-BAND	C-BAND	OMNI-DIRECTIONAL	PULSE	• SAME CODING IS UTILIZED FOR BOTH TRANSPONDERS BUT CODING DIFFERS FROM THAT USED BY CSM AND LAUNCH VEHICLE
TRACKING OF CSM	RENDEZVOUS RADAR	TWO	X-BAND	X-BAND	DIRECTIONAL	FM TRANSMIT FM RECEIVE	• THREE-TONE RANGE CODE AND CARRIER COHERENT TURN-AROUND • ACCURACY: (a) VELOCITY 1/4% OR 1 fps (b) RANGE 1% OR 20 feet (c) ANGLE 8mr bias 2mr random • ALSO USED FOR TRACKING OF TRACKING AID ON LUNAR SURFACE
OF TRACKING AID ON LUNAR SURFACE	RENDEZVOUS RADAR		X-BAND	X-BAND			• SEE "TRACKING OF CSM"
OF LUNAR SURFACE	LANDING RADAR	ONE	X-BAND	X-BAND	DIRECTIONAL	CW AND FM/CW TRANSMIT	• ACCURACY: (a) VELOCITY 1% OR 1 fps (b) RANGE 1% OR 5 feet

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NOTES:

1. THE MINIMUM WORD INTELLIGIBILITY SHALL BE 90% FOR NORMAL VOICE COMMUNICATIONS AND 70% FOR BACK-UP COMMUNICATIONS AS MEASURED BY USER PERSONNEL UNDER SIMULATED OPERATING CONDITIONS UTILIZING THE AMERICAN STANDARD METHOD FOR MEASUREMENT OF MONOSYLLABIC WORD INTELLIGIBILITY DATED MAY 25, 1960.

2. THE TELEMETRY SUBSYSTEM SHALL BE DESIGNED TO PROVIDE AN ERROR RATE NOT EXCEEDING ONE BIT IN 10^6 BITS FOR PCM TELEMETRY TRANSMISSIONS TO STATIONS OF THE MSFN AS MEASURED FROM LEM ENCODER TO MSFN DECODER.

3. THE TELEMETRY SUBSYSTEMS SHALL BE COMPATIBLE WITH THE INTER RANGE INSTRUMENTATION GROUP STANDARDS (IRIG DOCUMENT NO. 106-60 "TELEMETRY STANDARDS REVISED 1962") APPROPRIATE TO THE RESPECTIVE TELEMETRY SUBSYSTEMS.

4. THIS PCM TELEMETRY SUBSYSTEM SHALL BE CAPABLE OF TRANSMITTING THE PCM BIT STREAM REQUIRED FOR REAL-TIME USE VIA COAXIAL CABLE TO THE CHECKOUT FACILITY IN THE MILA PRIOR TO LIFT-OFF AND VIA AN RF LINK AFTER ADAPTER JETTISON.

5. THE TELEMETRY SUBSYSTEM SHALL BE DESIGNED TO PROVIDE AN ERROR RATE NOT EXCEEDING ONE BIT IN 10^6 BITS FOR PCM TELEMETRY TRANSMISSIONS TO THE CSM AS MEASURED FROM LEM ENCODER TO CSM RECORDER.

6. NO MORE THAN ONE CORRECT MESSAGE SHALL BE REJECTED PER 1000 CORRECT MESSAGES AND THAT NO MORE THAN ONE PER 10^9 INCORRECT MESSAGES SHALL BE ACCEPTED.

LEGEND

EQUIPMENT/FUNCTION THIS FLIGHT	EQUIPMENT/FUNCTION LUNAR MISSION	CODING
REQUIRED	REQUIRED	(blank)
REQUIRED	NOT REQUIRED	(single hatching)
NOT REQUIRED	REQUIRED	(stippled)
NOT REQUIRED	NOT REQUIRED	(cross hatching)

APPENDIX 207
TABLE 3.5-4B
LEM UNIFIED S-BAND COMMUNICATIONS AND TRACKING REQUIREMENTS
APOLLO-SATURN 207

SUBSYSTEM	EQUIPMENT IMPLEMENTATION	NUMBER OF UNITS	OPERATING FREQUENCY		ANTENNA SUBSYSTEM	MODULATION CHARACTERISTICS	REMARKS
			TRANSMIT	RECEIVE			
VOICE COMMUNICATION (SEE NOTE 1) WITH MSFN	TRANSPONDER (PM)	TWO	S-BAND	S-BAND	OMNI-DIRECTIONAL DIRECTIONAL - VARIABLE BEAMWIDTH	FM/PM TRANSMIT - 1.25 Mc SUBCARRIER FM/PM RECEIVE 30 Kc SUBCARRIER	• TRANSPONDER FREQUENCY SHALL BE COHERENT WITH SIGNALS RECEIVED FROM THE MSFN AND IN THE RATIO OF 240:221 • TRANSPONDER ALSO PROVIDES FOR TELEMETRY TRANSMISSION, KEYED TRANSMISSION, AND TRACKING ASSISTANCE TO THE MSFN • RELAY VOICE AND TELEMETRY COMMUNICATIONS WITH EVA • BACK-UP RELAY OF VOICE COMMUNICATIONS BETWEEN MSFN AND CSM
						PM TRANSMIT AT BASEBAND	• EMERGENCY VOICE TRANSMISSION TRANSMITTED ALONE
WITH MSFN	TRANSMITTER (FM)	ONE	S-BAND		ERECTABLE (ON LUNAR SURFACE)	FM/FM TRANSMIT 1.25 Mc SUBCARRIER	• THE FM TRANSMITTER IS NOT REQUIRED TO OPERATE SIMULTANEOUSLY WITH THE PM TRANSPONDER • VOICE RECEPTION IS ACHIEVED VIA PM RECEPTION OF 30 Kc FM SUBCARRIER • TRANSMITTER ALSO PROVIDES FOR TELEMETRY AND TELEVISION TRANSMISSION TO THE MSFN • TRANSMITTER SHALL UTILIZE TRANSPONDER ANTENNA SUBSYSTEM DURING R&D FLIGHT PROGRAM.
KEYING COMMUNICATIONS TO MSFN	TRANSPONDER (PM)		S-BAND			AM/PM 512 Kc SUBCARRIER	• SEE "VOICE COMMUNICATIONS WITH MSFN" • TRANSMITTED ALONE - BACK-UP FOR VOICE TRANSMISSION
TELEMETRY TO MSFN	TRANSMITTER (FM)		S-BAND			PCM/PM/FM 1.024 Mc SUBCARRIER NRZ-C SERIAL BIT STREAM	• SEE "VOICE COMMUNICATIONS WITH MSFN" • SELECTABLE BIT RATES OF 51.2 KILOBITS/SECOND AND 1.6 KILOBITS/SECOND • SEE NOTES 2 AND 3
						FM/FM/FM 7 SUBCARRIERS ON 1.25 Mc VOICE SUBCARRIER	• SEE "VOICE COMMUNICATIONS WITH MSFN" • RELAY OF COMPOSITE EVA VOICE AND 7 CHANNELS OF EVA TELEMETRY ON VOICE SUBCARRIER
TO MSFN	TRANSPONDER (PM)		S-BAND			PCM/PM/PM 1.024 Mc SUBCARRIER NRZ-C SERIAL BIT STREAM	• SEE "VOICE COMMUNICATIONS WITH MSFN" • SELECTABLE BIT RATES OF 51.2 KILOBITS/SECOND AND 1.6 KILOBITS/SECOND • SEE NOTES 2 AND 3
						FM/FM/PM 7 SUBCARRIERS ON 1.25 Mc VOICE SUBCARRIER	• SEE "VOICE COMMUNICATIONS WITH MSFN" • RELAY OF COMPOSITE EVA VOICE AND 7 CHANNELS OF EVA TELEMETRY ON VOICE SUBCARRIER
							• SCIENTIFIC DATA
TAPE PLAYBACK							• NOT APPLICABLE
TELEVISION TO MSFN	TRANSMITTER (FM)		S-BAND			FM AT BASEBAND	• SEE "VOICE COMMUNICATIONS WITH MSFN"
UP-DATA							• "NOT APPLICABLE
TRACKING AID TO MSFN	TRANSPONDER (PM)		S-BAND	S-BAND		PM RECEIVE- PRN CODE AT BASEBAND PM TRANSMIT- PRN CODE AT BASEBAND	• SEE "VOICE COMMUNICATIONS WITH MSFN" • COHERENT TURN-AROUND CARRIER • COHERENT TURN-AROUND RANGE CODE

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NOTES:

1. THE MINIMUM WORK INTELLIGIBILITY SHALL BE 90% FOR NORMAL VOICE COMMUNICATIONS AND 70% FOR BACK-UP COMMUNICATIONS AS MEASURED BY USER PERSONNEL UNDER SIMULATED OPERATING CONDITIONS UTILIZING THE AMERICAN STANDARD METHOD FOR MEASUREMENT OF MONOSYLLABIC WORD INTELLIGIBILITY DATED MAY 25, 1960

2. THE TELEMETRY SUBSYSTEM SHALL BE DESIGNED TO PROVIDE AN ERROR RATE NOT EXCEEDING ONE BIT IN 10^6 BITS FOR PCM TELEMETRY TRANSMISSIONS TO STATIONS OF THE MSFN AS MEASURED FROM CSM ENCODER TO MSFN DECODER.

3. THIS PCM TELEMETRY SUBSYSTEM SHALL BE CAPABLE OF TRANSMITTING THE PCM BIT STREAM REQUIRED FOR REAL-TIME USE VIA COAXIAL CABLE TO THE CHECKOUT FACILITY IN THE MILA PRIOR TO LIFT-OFF AND VIA AN RF LINK AFTER ADAPTER JETTISON.

LEGEND

EQUIPMENT/FUNCTION		CODING
THIS FLIGHT	LUNAR MISSION	
REQUIRED	REQUIRED	
REQUIRED	NOT REQUIRED	(diagonal hatching)
NOT REQUIRED	REQUIRED	
NOT REQUIRED	NOT REQUIRED	(cross-hatching)

APPENDIX 207
TABLE 3.7-1
REQUIRED CSM COVERAGE
APOLLO-SATURN 207

SUBSYSTEM \ PHASE	S-IB BURN	S-IVB BURN	END OF S-IVB BURN +3 MINUTES	COAST IN EARTH ORBIT [1]	CSM & S-IVB/IU CHECKOUT IN EARTH ORBIT [2]	TRANSPOSITION AND SEPARATION	LEM CHECKOUT	SPACECRAFT TRANSFER TO NEW ORBIT	CSM-LEM RENDEZVOUS AND DOCK	LEM MAIN ENGINE BURNS	LEM JETTISON	CSM COAST PERIODS	EVA EXTERNAL TO SPACECRAFT	PRE-ENTRY SPS BURN	ENTRY
VHF															
VOICE				///		///	///	///	///	///	///	///	///		
TELEMETRY				///		///	///	///	///	///	///	///	///		
C-BAND															
TRACKING [3]				///		///	///	///	///	///	///	///	///	///	///
S-BAND															
VOICE				///		///		///	///	///	///	///			///
TELEMETRY				///		///		///	///	///	///	///			///
UP-DATA				///		///		///	///	///	///	///			
TRACKING [3]				///		///	///	///	///	///	///	///			///
TELEVISION				///		///			///	///		///	///		

3/1/66

1. GAP BETWEEN CONTACTS SHALL BE NO GREATER THAN 1/2 ORBIT CONTACTS SHALL BE AT LEAST 3 MINUTES LONG.

2. THIS REQUIREMENT MAY BE SATISFIED DURING AN ORBITAL CONTACT.

3. S-BAND TRACKING SHALL PROVIDE DIRECT MEASUREMENT OF SPACECRAFT ANGLE, RANGE AND RANGE RATE. C-BAND TRACKING SHALL PROVIDE DIRECT MEASUREMENT OF SPACECRAFT ANGLE AND RANGE.

/// PARTIAL COVERAGE
CONTINUOUS COVERAGE
NOT REQUIRED

TABLE 3.7-1
APOLLO-SATURN 207

APPENDIX 207
TABLE 3.7-2
REQUIRED LEM COVERAGE
APOLLO-SATURN 207

SUBSYSTEM \ PHASE	S-IB BURN	S-IVB BURN	END OF S-IVB BURN +3 MINUTES	COAST IN EARTH ORBIT [1]	CSM & S-IVB/IU CHECKOUT IN EARTH ORBIT [2]	TRANSPOSITION AND SEPARATION	LEM CHECKOUT	SPACECRAFT TRANSFER TO NEW ORBIT	CSM-LEM RENDEZVOUS AND DOCK	LEM MAIN ENGINE BURNS	LEM COAST PERIODS	EVA EXTERNAL TO SPACECRAFT	LEM JETTISON
VHF													
VOICE								///	///		///	///	
TELEMETRY				///	///	///		///	///		///	///	///
UHF													
UP-DATA				///	///	///		///	///		///	///	
C-BAND													
TRACKING [3]								///	///		///	///	///
S-BAND													
VOICE								///	///		///		
TELEMETRY								///	///		///		///
TRACKING [3]								///	///		///		///
TELEVISION											///		

3/1/66

1. GAP BETWEEN CONTACTS SHALL BE NO GREATER THAN 1/2 ORBIT, CONTACTS SHALL BE AT LEAST 3 MINUTES LONG.

2. THIS REQUIREMENT MAY BE SATISFIED DURING AN ORBITAL CONTACT.

3. S-BAND TRACKING SHALL PROVIDE DIRECT MEASUREMENT OF LEM ANGLE, RANGE AND RANGE RATE. C-BAND TRACKING SHALL PROVIDE DIRECT MEASUREMENT OF LEM ANGLE AND RANGE.

/// PARTIAL COVERAGE
CONTINUOUS COVERAGE
NOT REQUIRED

TABLE 3.7-2
APOLLO-SATURN 207

Apollo Saturn Missions 501 and 502

1.0 Scope This appendix to the Apollo Program Specification identifies the performance, design and test requirements which apply to the Program elements to be utilized for Apollo Saturn Missions 501 and 502 (AS-501 and AS-502). These requirements are presented in this appendix as deviations to the requirements specified for equipment for the lunar landing mission. Unless otherwise noted, the paragraphs in this appendix replace in their entirety the identically numbered paragraphs in the body of the specification.

1.1 Applicability No change.[1]

1.2 Change Approval No change.

2.0 Applicable Documents No change.

3.0 Requirements

3.1 Performance

3.1.1 Characteristics

3.1.1.1 General Add: To the extent practicable, the hardware used on AS-501 and AS-502 shall be of the same design as that to be used for the lunar landing mission.

3.1.1.2 Mission Performance

3.1.1.2.1 Mission Mode For these Apollo test missions the Saturn V launch vehicle, consisting of an S-IC first stage, an S-II

(1) The phrase "no change" is used after a section heading throughout this appendix to mean that the requirement in the body of the specification applies to this mission without change.

second stage, an S-IVB third stage, and an Instrument Unit (IU) shall launch the spacecraft, propel it through an Earth parking orbit phase and then into an elliptical trajectory for achieving the desired entry conditions. The spacecraft, which includes an unmanned Command Module (CM) and a Service Module (SM), shall utilize the SM for propulsion after injection into the elliptical trajectory to achieve lunar return entry conditions. The SM shall be jettisoned prior to entry of the CM into the Earth's atmosphere. The CM shall be slowed to a safe landing by aerodynamic braking and, during the final phases of the landing sequence, by parachute.

3.1.1.2.2 Mission Command A Mission Control Programmer (MCP) shall be provided on board the CM which, in conjunction with the CM guidance computer, shall provide all spacecraft commands necessary for accomplishment of the mission. The MCP shall be capable of receiving signals from ground-based personnel as a backup. The MSFN, including ETR stations, shall be used for communications with the space vehicle and for tracking the space vehicle (those stages of the launch vehicle and those modules of the spacecraft not jettisoned at the particular point in the mission).

3.1.1.2.3 Payload The payload for this mission shall be a spacecraft with a structural test unit in place of the LEM. The objectives of this mission shall include those identified in Apollo Flight Mission Assignments, M-D MA 500-11.

3.1.1.2.4 Earth Launch Launch capability shall be provided to permit an initial flight azimuth of 072°.

3.1.1.2.5 Earth Parking Orbit No change.

Apollo Saturn Missions 501 and 502

3.1.1.2.6 Injection Opportunities Not Applicable. (N/A).[2]

3.1.1.2.7 Lunar Landing Accuracy N/A.

3.1.1.2.8 Lunar Exploration N/A.

3.1.1.2.9 Earth Landing The normal Earth landing mode shall be on water. The capability for water and land landing shall be as specified in 3.5.1.24.

3.1.1.2.10 Recovery Delete reference to crew.

3.1.2 Program Definition No change.

3.1.3 Operability No change except delete reference to crew and in 3.1.3.3.2 change "the lunar mission" to "this mission" and delete reference to the lunar surface.

3.2 Program Standards No change.

3.3 Saturn IB Launch Vehicle N/A.

3.4 Saturn V Launch Vehicle

3.4.1 General No change except that the launch vehicle control weights shall be as specified for AS-501 and for AS-502 in Table 10.1-2, Appendix 10.1.

3.4.1.1 Payload The launch vehicle shall provide the payload capability specified for AS-501 and for AS-502 in Table 10.1-2, Appendix 10.1.

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(2) The phrase "not applicable" is used after a section heading throughout this appendix to mean that the requirement in the body of the specification does not apply to this mission.

Apollo Saturn Missions 501 and 502

3.4.1.2 Standby Time The launch vehicle shall have the capability to stand by in a loaded condition with propellant topping for 12 hours and still perform the mission.

3.4.1.3 Prelaunch Checkout No change.

3.4.1.4 In-Flight Performance Evaluation No change.

3.4.1.5 Emergency Detection Subsystem (EDS) AS-501: No change except that the EDS shall be operated in an open loop mode. The capability shall be provided to shut down the launch vehicle engines upon ground command via the spacecraft up-data system. AS-502: No change.

3.4.1.6 Instrumentation An instrumentation subsystem shall be provided in the launch vehicle to permit ground personnel to monitor and evaluate launch vehicle performance.

3.4.1.7 Command Destruct No change.

3.4.1.8 Electrical Power No change.

3.4.1.9 Attitude Control The S-IVB stage in conjunction with the IU shall be capable of maintaining the space vehicle at commanded attitudes for 4.5 hours in Earth orbit. In addition, it shall maintain commanded attitudes for injection into elliptical trajectory and for spacecraft separation.

3.4.2 Structure No change.

3.4.3 Propulsion No change except J-2 engine vacuum thrust shall be 200,000 ± 6,000 pounds in section 3.4.3.2.1.2. Each F-1 engine shall provide a sea level thrust of $1{,}500{,}000^{+45{,}000}_{-0}$ pounds.

Apollo Saturn Missions 501 and 502

3.4.4 Guidance, Navigation and Control

3.4.4.1 General The launch vehicle guidance, navigation and control system shall provide the guidance, navigation and control functions which are required for the space vehicle from liftoff through separation of the spacecraft from the launch vehicle. The principal elements shall be an inertial measurement unit (IMU), a digital computer and control electronics. These elements shall be located in the IU.

3.4.4.1.1 No change.

3.4.4.1.2 N/A.

3.4.4.2 Accuracy To be provided.

3.4.5 Saturn V Launch Vehicle Communications and Tracking

3.4.5.1 General Add: (e) Television transmission (on AS-502 only).

3.4.5.2 Functional Capability Add:

3.4.5.2.5 Television The television subsystem on the S-IC stage of Apollo Saturn 502 shall provide transmission to the CIF in the launch area during the launch phase.

3.4.5.3 Coverage Capability The Saturn V Communication and Tracking System shall be able to operate with the MSFN to achieve the coverage specified in Table 3.7-3 (501/502) of this appendix.

3.4.5.4 Performance The Saturn V Communication and Tracking System shall meet the requirements specified in Table 3.4-1 (501/502) of this appendix.

3.5 Spacecraft

3.5.1 General The spacecraft shall be composed of a CM, SM, LES, Adapter and a structural test unit replacing the LEM. The spacecraft shall be designed to be mated to a Saturn V launch vehicle.

Apollo Saturn Missions 501 and 502

Spacecraft control weights shall be as specified for AS-501 and AS-502 in Table 10.1-4, Appendix 10.1.

An instrumentation subsystem shall be provided in the spacecraft which shall permit ground personnel to monitor and evaluate spacecraft performance. The spacecraft shall be capable of utilizing data from Earth-based tracking and computing facilities in conjunction with onboard computations.

No equipment or components critical to the completion of the mission shall be dependent on the cabin atmosphere for electrical insulation or thermal conditioning. Only those materials which do not present a fire hazard or emit harmful quantities of atmospheric contaminants when exposed to an oxygen-enriched, low-pressure environment shall be used in the pressurized inner structural envelope of the CM.

3.5.1.1 through 3.5.1.3 No change.

3.5.1.4 Standby Time The spacecraft shall have the capability to stand by in a loaded condition, after launch vehicle propellant loading, for 10 hours and still perform the mission.

3.5.1.5 Launch and Flight Environment No change.

3.5.1.6 Earth Orbit Environment The spacecraft shall be capable of operating in the terrestrial space environment as given in Section 3 of M-DE 8020.008B.

3.5.1.7 through 3.5.1.17 N/A.

3.5.1.18 Sterilization No change.

3.5.1.19 through 3.5.1.21 N/A.

3.5.1.22 Entry The CM shall be capable of controlled flight through the Earth's atmosphere (as given in 2.5 of M-DE 8020.008B) to a preselected impact area having a ground range of 2500 nm from the entry point (defined as the point at which the vehicle first descends through the 400,000 feet altitude level). This shall be possible without exceeding a 10g deceleration for a nominal inertial entry velocity of 36,300 fps and an equatorial inclination of 40°. The design limit entry load for all CM systems shall be a 20g deceleration.

3.5.1.23 Aerodynamic Characteristics No change.

3.5.1.24 Landing No change.

3.5.1.25 Postlanding The CM shall be capable of floating for seven days under conditions given in 2.8 of M-DE 8020.008B.

3.5.1.26 Recovery The CM shall be equipped with recovery aids to assist recovery forces in locating it and in effecting recovery of the vehicle.

3.5.2 Command and Service Module

3.5.2.1 Structure

3.5.2.1.1 Cabin Space N/A. See 3.1.1.1 (AS-501/502)

3.5.2.1.2 Windows N/A. See 3.1.1.1 (AS-501/502)

3.5.2.1.3 Ingress and Egress N/A. See 3.1.1.1 (AS-501/502)

3.5.2.1.4 Docking N/A.

3.5.2.1.5 Thermal Requirements No change.

3.5.2.1.6 Extravehicular Mobility Unit (EMU) Storage N/A. See 3.1.1.1 (AS-501/502).

3.5.2.2 CSM Propulsion

3.5.2.2.1 General Thrust, specific impulse, minimum impulse and propellants for CSM propulsion subsystems shall be as specified in Table 3.5-1 except that SPS thrust shall be 21,500 $\pm$ 215 pounds, SPS nominal vacuum specific impulse shall be 311.2 seconds and SPS minimum vacuum specific impulse shall be 307.6 seconds. The service life of propulsion subsystems after pre-mission testing shall allow the engines to be fired for sufficient time to deplete propellants available when all propellant tanks are loaded to the maximum capacity.

Apollo Saturn Missions 501 and 502

3.5.2.2.2 Command Module Reaction Control Subsystem No change except delete provisions for dumping unburned propellant.

3.5.2.2.3 Service Module Reaction Control Subsystem No change except delete reference to LEM.

3.5.2.2.4 Service Module Propulsion Subsystem The SPS shall provide thrust for translational maneuvers of the CSM.

3.5.2.3 CSM Communications and Tracking

3.5.2.3.1 General The CSM Communication and Tracking System shall provide the following capabilities:

(a) Simulated voice communications.

(b) Telemetry transmission.

(c) Tracking aid.

(d) Up-data reception.

(e) Recovery beacon transmission.

3.5.2.3.2 Functional Capability

3.5.2.3.2.1 Voice Communications A single-frequency tone shall be used to simulate voice communication from:

(a) The CSM to the MSFN.

(b) The CSM to the launch complex prior to liftoff.

(c) The CM to the recovery forces.

3.5.2.3.2.2 Telemetry The telemetry subsystem shall be able to:

(a) Transmit operational data from the CSM to the MSFN.

(b) Transmit the data required for postflight analysis.

(c) Operate continuously from liftoff to Earth impact.

3.5.2.3.2.3 Tracking Aid The tracking aid subsystem shall enable the MSFN to track the CSM.

3.5.2.3.2.4 Up-Data The up-data subsystem shall be able to:

(a) Receive data from the MSFN.

(b) Supply up-data verification signals to the MSFN via the CSM telemetry subsystem.

3.5.2.3.2.5 Television N/A.

3.5.2.3.2.6 Recovery Beacon No change.

3.5.2.3.3 Coverage Capability

3.5.2.3.3.1 CSM-MSFN The Communication and Tracking System shall be able to operate with the MSFN to achieve the coverage specified in Table 3.7-1 (501/502) of this appendix.

3.5.2.3.3.2 CSM-LEM N/A.

3.5.2.3.3.3 CSM-EVA N/A.

3.5.2.3.4 Performance The CSM Communication and Tracking System shall meet the requirements specified in Table 3.5-2A (501/502) and Table 3.5-2B (501/502) of this appendix.

3.5.2.4 Electrical Power Subsystem

3.5.2.4.1 General The CSM EPS shall generate and distribute all of the electrical power required by the CSM during all phases of the flight plus 48 hours of the postlanding recovery period. Until SM separation, the source of electrical power shall be fuel cells and batteries. After SM separation, CM power shall be supplied by batteries.

3.5.2.4.2 Nominal Capacity The EPS shall utilize three liquid hydrogen and liquid oxygen fuel cells, and shall be capable of supplying a total of 575 kwh of electrical energy. Each fuel cell shall be capable of supplying power over a range from 565 watts to 1400 watts. In addition to the three entry and postlanding batteries, three 40 amp-hr batteries shall be available to supply extra power required by the mission programmer and R&D instrumentation. The EPS shall be capable of recharging the entry and postlanding batteries.

3.5.2.4.3 Sizing N/A.

3.5.2.4.4 Water and Oxygen Supply The EPS shall supply water and oxygen to the ECS.

3.5.2.4.5 and 3.5.2.4.6 No change.

3.5.2.5 Integrated Navigation, Guidance and Control System

3.5.2.5.1 General The navigation, guidance and control system shall be composed of the CM Primary Navigation, Guidance and Control System (PNGCS) and the Stabilization and Control System (SCS) with common usage of some elements.

The Primary Navigation Guidance and Control System (PNGCS) and the Stabilization and Control System (SCS) shall be used in conjunction with the Mission Control Programmer (MCP) to provide the CSM with the capability of executing unmanned Apollo Saturn 501 and 502 flight sequences after CSM separation from the launch vehicle and for guiding the CM to the designated landing area. The MCP and SCS shall also provide CSM control as a backup mode of operation.

Spacecraft control during the mission shall be provided by the Apollo Guidance Computer (AGC) in conjunction with the MCP. As a backup, the MCP shall be able to accept discrete ground commands independent of the PNGCS so as to provide spacecraft control.

3.5.2.5.1.1 The principal elements of the PNGCS shall be an IMU, a digital computer, an optical subsystem and controls.

3.5.2.5.1.2 The principal elements of the SCS shall be gyroscopes, an accelerometer rigidly mounted to the CM structure, control electronics and controls.

3.5.2.5.1.3 The PNGCS shall provide means for checkout on the launch pad utilizing the prelaunch checkout equipment.

3.5.2.5.1.4 The PNGCS shall:

(a) Permit the AGC to accept commands and navigation data from the MSFN via the up-data link.

(b) Provide means for monitoring the position, velocity and attitude of the Apollo space vehicle during burns of the S-IC, S-II and S-IVB stages.

(c) Provide for alignment of the SCS inertial attitude reference from the PNGCS.

(d) Provide for prelaunch alignment of the PNGCS IMU.

3.5.2.6 Display and Control Subsystem N/A.

3.5.2.7 Environmental Control Subsystem The CSM shall be equipped with a nonregenerative Environmental Control Subsystem (ECS) which shall provide a conditioned atmosphere and thermal control for the pressurized inner structural envelope. The ECS shall also provide thermal control of equipment where needed.

3.5.2.7.1 Atmospheric Supply The pressurized inner structural envelope shall be supplied with pure oxygen to maintain a partial pressure of oxygen not less than 180 mm Hg throughout the mission and not more than 300 mm Hg throughout the mission after the launch phase, referenced to 70°F dry bulb. The primary source of oxygen shall be the EPS located in the SM. The ECS shall be capable of maintaining a cabin pressure of not less than 3.5 psia for at least 15 minutes following a 0.25-inch diameter puncture. This capability shall not be required in the CM after SM separation. The ECS shall provide stored oxygen in the CM for use from SM separation to CM touchdown.

3.5.2.7.1.1 Atmospheric Control No change except delete reference to crew.

3.5.2.7.2 Water Management In addition to water loaded on board at launch, the ECS shall receive water from the EPS. Arrangements shall be made for storing collected condensate separately.

3.5.2.7.3 EMU Support N/A.

3.5.2.8 Crew Equipment N/A.

3.5.3 Lunar Excursion Module The requirements of section 3.5.3 in the body of the specification are replaced in entirety by the following requirements.

3.5.3.1 LEM Structural Test Unit A LEM structural test unit shall be provided to approximate the LEM structural effects on the space vehicle. The following requirements shall be satisfied by the structural test unit:

(a) It shall utilize the LEM attachment points in the Adapter.

(b) It shall approximate the LEM weight.

(c) It shall approximate the LEM center of gravity.

(d) It shall approximate the LEM moment of inertia.

3.5.3.2 Structural Test Unit Communications and Tracking

3.5.3.2.1 Functional Capability The structural test unit shall be equipped with a telemetry subsystem to:

(a) Transmit the data required for postflight analysis.

(b) Operate continuously from liftoff through CSM separation.

3.5.3.2.2 Coverage Capability The structural test unit telemetry subsystem shall be able to operate with the MSFN to achieve the coverage specified in Table 3.7-1 (501/502) of this appendix.

3.5.3.2.3 Performance The structural test unit telemetry subsystem shall meet the requirements specified in the following table:

Equipment Implementation	Operating Frequency	Antenna Subsystem	Modulation Characteristics
VHF Telemeter	225-260 Mc	The output of all telemeters shall be multiplexed on a common omni-directional antenna.	FM
VHF Telemeter	225-260 Mc		PAM/FM/FM(3)
VHF Telemeter	225-260 Mc		FM

3.5.4 Launch Escape System

3.5.4.1 The LES shall be capable of removing the CM from a malfunctioning space vehicle without exceeding the structural limit of the CM/LES. It shall provide terminal conditions for the CM which permit safe entry into the lower atmosphere and deployment of the ELS.

3.5.4.2 The LES shall provide abort capability from before until shortly after second stage ignition when the LES shall be jettisoned. The LES shall be capable of separating from the space vehicle during a normal mission without degrading space vehicle performance.

3.5.5 Adapter No change.

3.5.6 Extravehicular Mobility Unit N/A.

3.5.7 Scientific Payload N/A.

(3) This telemetry subsystem shall be compatible with the Inter Range Instrumentation Group Standards (IRIG Document No. 106-60, "Telemetry Standards Revised 1962").

Apollo Saturn Missions 501 and 502

3.5.8 Flight Crew Training Equipment N/A.

3.6 Launch Area

3.6.1 General No change.

3.6.2 Space Vehicle Checkout Systems No change.

3.6.3 Launch Complexes 34 and 37B N/A.

3.6.4 Launch Complex 39 Delete manned Apollo Saturn V requirements.

3.6.4.1 Vertical Assembly Building No change.

3.6.4.2 Launcher-Umbilical Tower No change.

3.6.4.3 Crawler Transporter No change.

3.6.4.4 Launch Pads No change.

3.6.4.5 Arming Tower No change.

3.6.4.6 Launch Control Center No change except paragraph (g) is not applicable.

3.6.5 Direct Launch Support Facilities

3.6.5.1 Operations and Checkout Building No change except delete requirement for monitoring astronaut performance in paragraph (e).

3.6.5.2 Central Instrumentation Facility Add for AS-502: (f) Receiving and recording television signals from the S-IC stage.

3.6.5.3 Central Telephone Office No change.

3.7 Manned Space Flight Network

3.7.1 General No change.

3.7.2 Functional Capability

3.7.2.1 Voice Communications The voice communication subsystem shall enable:

(a) Simulated voice communications between the CSM and the MCC.

(b) Duplex, 4-wire voice communications between MSFN stations and the MCC.

3.7.2.2 Telemetry The telemetry subsystem shall be able to receive:

(a) Operational data from the CSM.

(b) Operational data from each stage of the launch vehicle and the IU simultaneously with (a).

(c) Engineering data from the space vehicle simultaneously with (a) and (b).

3.7.2.3 Tracking The tracking subsystem shall be able to:

(a) Track in angle and range the radar transponders in the IU and CSM during flight.

(b) Track the transponders in the launch vehicle in angle, range and range rate during the launch phase.

(c) "Skin" track the CM during entry.

(d) Provide sampled tracking data for transmission to the MCC and, where required for on-site computation.

3.7.2.4 Digital Command Communications No change.

3.7.2.5 Television N/A.

3.7.2.6 Display and Control The LEM reference is not applicable.

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3.7.2.7 Data Processing No change.

3.7.2.8 Timing No change.

3.7.3 Coverage Capability The MSFN station in the launch area shall be able to support the prelaunch checkout of the space vehicle on the launch pad.

The MSFN shall provide the coverage capabilities for:

(a) The CSM and structural test unit as specified in Table 3.7-1 (501/502) of this appendix.

(b) The Saturn V launch vehicle as specified in Table 3.7-4 (501/502) of this appendix.

3.7.4 Performance No change except the MSFN shall operate with the space vehicle subsystems as specified in 3.4.5, 3.5.2.3. and 3.5.3.2 of this appendix.

3.8 Mission Control Center No change except delete 3.8.1 (d).

4.0 Quality Assurance No change.

APPENDIX 501/502

TABLE 3. 4 - 1

SATURN V LAUNCH VEHICLE COMMUNICATIONS AND TRACKING REQUIREMENTS

APOLLO - SATURN 501/502

STAGE	SUBSYSTEM	EQUIPMENT IMPLEMENTATION	NUMBER OF UNITS	OPERATING FREQUENCY TRANSMIT	OPERATING FREQUENCY RECEIVE	ANTENNA SUBSYSTEM	MODULATION CHARACTERISTICS	REMARKS
S - IC	TELEMETRY	PCM/FM TELEMETER	ONE	225-260 Mc		OMNI-DIRECTIONAL	PCM/FM	• SEE NOTES 1, 2 AND 3 • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND
		FM/FM TELEMETER	ONE	225-260 Mc		SEE NOTE 5	FM/FM	• SEE NOTES 1 AND 4 • PAM/FM/FM MODULATION UTILIZED DURING R & D FLIGHT PROGRAM
		PAM/FM/FM TELEMETER	TWO	225-260 Mc		SEE NOTE 5	PAM/FM/FM	• SEE NOTES 1 AND 4
		SS/FM TELEMETER	TWO	225-260 Mc		SEE NOTE 5	SS/FM	• SEE NOTE 4
	COMMAND DESTRUCT	RECEIVER AND DECODER	TWO		400-450 Mc	OMNI-DIRECTIONAL		• THIS SYSTEM SHALL BE COMPATIBLE WITH RANGE SAFETY COMMAND TRANSMITTERS INSTALLED AT STATIONS OF THE ETR
	TRACKING	ODOP TRANSPONDER	ONE	UHF	UHF	FIXED DIRECTIONAL		
	TELEVISION	TELEVISION TRANSMITTER	ONE	1700-1730 Mc				• NOT CARRIED ON AS - 501
S - II	TELEMETRY	PCM/FM TELEMETER	ONE	225-260 Mc		OMNI-DIRECTIONAL	PCM/FM	• SEE NOTES 1, 2 AND 3 • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND
		FM/FM TELEMETER	TWO	225-260 Mc		SEE NOTE 5	FM/FM	• SEE NOTES 1 AND 4 • PAM/FM/FM MODULATION UTILIZED DURING R & D FLIGHT PROGRAM
		PAM/FM/FM TELEMETER	ONE	225-260 Mc		SEE NOTE 5	PAM/FM/FM	• SEE NOTES 1 AND 4
		SS/FM TELEMETER	TWO	225-260 Mc		SEE NOTE 5	SS/FM	• SEE NOTE 4
	COMMAND DESTRUCT	RECEIVER AND DECODER	TWO		400-450 Mc	OMNI-DIRECTIONAL		• THIS SYSTEM SHALL BE COMPATIBLE WITH RANGE SAFETY COMMAND TRANSMITTERS INSTALLED AT STATIONS OF THE ETR
S - IVB	TELEMETRY	PCM/FM TELEMETER	ONE	225-260 Mc		OMNI-DIRECTIONAL	PCM/FM	• SEE NOTES 1, 2 AND 3 • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND
		FM/FM TELEMETER 6	ONE	225-260 Mc		SEE NOTE 5	FM/FM	• SEE NOTES 1 AND 4 • PAM/FM/FM MODULATION UTILIZED DURING R & D FLIGHT PROGRAM
		PAM/FM/FM TELEMETER	TWO	225-260 Mc		SEE NOTE 5	PAM/FM/FM	• SEE NOTES 1 AND 4
		SS/FM TELEMETER	ONE	225-260 Mc		SEE NOTE 5	SS/FM	• SEE NOTE 4
	COMMAND DESTRUCT	RECEIVER AND DECODER	TWO		400-450 Mc	OMNI-DIRECTIONAL		• THIS SYSTEM SHALL BE COMPATIBLE WITH RANGE SAFETY COMMAND TRANSMITTERS INSTALLED AT STATIONS OF THE ETR
INSTRUMENT UNIT	TELEMETRY	PCM/FM TELEMETER	ONE	225-260 Mc		OMNI-DIRECTIONAL	PCM/FM	• SEE NOTES 1, 2 AND 3 • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND • THE TELEMETRY SHALL CONTAIN ALL S-IVB/IU MISSION CONTROL DATA
		PCM/FM TELEMETER	ONE	S-BAND		FIXED DIRECTIONAL VARIABLE BEAMWIDTH	PCM/FM	• SEE NOTES 1 AND 2 • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND • TRANSMITS THE SAME BIT STREAM AS THE IU VHF PCM/FM TELEMETER
		FM/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF IU VHF PCM/FM TELEMETER	FM/FM	• SEE NOTES 1 AND 4
		PAM/FM/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF IU VHF PCM/FM TELEMETER	PAM/FM/FM	• SEE NOTES 1 AND 4
		SS/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF IU VHF PCM/FM TELEMETER	SS/FM	• SEE NOTES 4
		COMMAND AND COMMUNICATION SYSTEM (CCS)	ONE	S-BAND		MULTIPLEXED WITH OUTPUT OF IU S-BAND PCM/FM TELEMETER	PCM/PM/PM	• THIS SYSTEM SHALL PROVIDE TELEMETRY TRANSMISSION, UP-DATA RECEPTION AND TRACKING ASSISTANCE TO THE MSFN • UTILIZES SAME OPERATING FREQUENCIES AS THE LEM USB SYSTEM • SEE NOTE 2 • THE CCS TRANSMITS THE SAME BIT STREAM AS THE S-IVB VHF PCM/FM TELEMETER AT A BIT RATE OF 72 KILOBITS/SECOND
	UP - DATA	CCS			S-BAND		PSK/FM/PM SUBCODED 5-BIT WORDS AT 1000 BITS/SECOND	• NO MORE THAN ONE CORRECT MESSAGE SHALL BE REJECTED PER 1000 CORRECT MESSAGES AND NO MORE THAN ONE PER 10^9 INCORRECT MESSAGES SHALL BE ACCEPTED
	TRACKING AID	CCS		S-BAND	S-BAND		PM	• TRANSMITTED FREQUENCY SHALL BE IN THE RATIO OF 240:221 TO THE RECEIVED FREQUENCY • COHERENT TURN-AROUND CARRIER • COHERENT TURN-AROUND RANGE CODE
		C-BAND RADAR TRANSPONDER	ONE	C-BAND	C-BAND	OMNI-DIRECTIONAL	PULSE	• UTILIZES CODING DIFFERENT FROM C-BAND RADAR TRANSPONDERS ON SPACECRAFT
		AZUSA TRANSPONDER	ONE	C-BAND	C-BAND	OMNI-DIRECTIONAL	FM	

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NOTES:

1. THIS TELEMETRY SUBSYSTEM SHALL BE COMPATIBLE WITH THE INTER RANGE INSTRUMENTATION GROUP STANDARDS (IRIG DOCUMENT NO. 106-60 "TELEMETRY STANDARDS REVISED 1962").

2. ALL PCM TELEMETRY SUBSYSTEMS SHALL BE DESIGNED TO PROVIDE AN ERROR RATE NOT EXCEEDING ONE IN 10^6 BITS FOR TRANSMISSIONS TO THE MSFN AS MEASURED FROM LAUNCH VEHICLE ENCODER TO EARTH-BASED DECODER.

3. THIS PCM/FM TELEMETRY SUBSYSTEM SHALL TRANSMIT THE PCM BIT STREAM REQUIRED FOR REAL-TIME USE VIA COAXIAL CABLE TO THE CHECKOUT FACILITY IN THE MILA PRIOR TO LIFT-OFF AND VIA AN RF LINK PRIOR TO AND AFTER LIFT-OFF.

4. THIS TELEMETRY SUBSYSTEM SHALL TRANSMIT DATA REQUIRED ONLY FOR POST-MISSION ANALYSIS VIA AN RF LINK.

5. UP TO 4 VHF STAGE TELEMETERS SHALL BE MULTIPLEXED ON A COMMON ANTENNA SUBSYSTEM. WHEN MORE THAN 4 VHF STAGE TELEMETERS ARE CARRIED, A SECOND OMNI-DIRECTIONAL ANTENNA SUBSYSTEM SHALL BE PROVIDED.

6. NOT PRESENTLY SCHEDULED FOR OPERATIONAL SATURN V LAUNCH VEHICLES. HOWEVER, PROVISIONS TO CARRY THIS TELEMETER SHALL BE INCORPORATED ON ALL SATURN V LAUNCH VEHICLES THROUGH AS-506.

LEGEND

EQUIPMENT/FUNCTION THIS FLIGHT	EQUIPMENT/FUNCTION LUNAR MISSION	CODING
REQUIRED	REQUIRED	
REQUIRED	NOT REQUIRED	
NOT REQUIRED	REQUIRED	
NOT REQUIRED	NOT REQUIRED	

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APPENDIX 501/502

TABLE 3.5-2A

CSM COMMUNICATIONS AND TRACKING REQUIREMENTS

APOLLO-SATURN 501/502

SUBSYSTEM	EQUIPMENT IMPLEMENTATION	NUMBER OF UNITS	OPERATING FREQUENCY TRANSMIT	OPERATING FREQUENCY RECEIVE	ANTENNA SUBSYSTEM	MODULATION CHARACTERISTICS	REMARKS
VOICE COMMUNICATIONS (SEE NOTE 1)	UNIFIED S-BAND SYSTEM						● SEE TABLE 3.5-2B FOR REQUIREMENTS
WITH MSFN	VHF TRANSCEIVER #1	ONE	VHF	VHF	OMNI-DIRECTIONAL	DSBAM TRANSMIT DSBAM RECEIVE	● ALTERNATE NEAR-EARTH VOICE COMMUNICATIONS CHANNEL VIA SIMPLEX MODE OF OPERATION ● PRIMARY VOICE COMMUNICATIONS CHANNEL WITH LEM VIA SIMPLEX MODE OF OPERATION ● PRIMARY TRANSMITTER FOR DUPLEX VOICE COMMUNICATIONS WITH EVA ● ALTERNATE BACK-UP FOR VOICE COMMUNICATIONS WITH EVA VIA SIMPLEX MODE OF OPERATION ● ALTERNATE VOICE COMMUNICATIONS CHANNEL WITH RECOVERY FORCES VIA SIMPLEX MODE OF OPERATION ● PROVIDES BEACON MODE OF OPERATION FOR DF AFTER LANDING
WITH MSFN	VHF TRANSCEIVER #2		VHF	VHF	MULTIPLEXED WITH TRANSCEIVER #1	DSBAM TRANSMIT DSBAM RECEIVE	● UTILIZED FOR VOICE AND DATA TRANSMISSION SIMULATION DURING R & D FLIGHT PROGRAM ● SEE "VOICE COMMUNICATIONS WITH LEM"
WITH LEM	VHF TRANSCEIVER #1		VHF	VHF			● SEE "VOICE COMMUNICATIONS WITH MSFN"
WITH LEM	VHF TRANSCEIVER #2	ONE	VHF	VHF	MULTIPLEXED WITH TRANSCEIVER #1	DSBAM TRANSMIT DSBAM RECEIVE	● BACK-UP VOICE COMMUNICATIONS CHANNEL WITH LEM VIA SIMPLEX MODE OF OPERATION ● RECEIVES LEM PCM/AM DATA ● PRIMARY RECEIVER FOR DUPLEX VOICE COMMUNICATIONS WITH EVA ● RECEIVES EVA BIOMEDICAL DATA SIMULTANEOUSLY WITH EVA VOICE ● ALTERNATE BACK-UP FOR VOICE COMMUNICATIONS WITH EVA VIA SIMPLEX MODE OF OPERATIONS
WITH EVA	VHF TRANSCEIVER #1		VHF	VHF			● SEE "VOICE COMMUNICATIONS WITH MSFN"
WITH EVA	VHF TRANSCEIVER #2		VHF	VHF			● SEE "VOICE COMMUNICATIONS WITH LEM"
WITH RECOVERY FORCES	HF TRANSCEIVER	ONE	HF	HF	OMNI-DIRECTIONAL	AM, CW, SSB	● PROVIDES BEACON MODE OF OPERATION FOR DF AFTER LANDING ● HF RECOVERY ANTENNA DEPLOYED AFTER LANDING
WITH RECOVERY FORCES	VHF TRANSCEIVER #1		VHF	VHF	MULTIPLEXED WITH VHF BEACON ANTENNA AFTER ENTRY		● SEE "VOICE COMMUNICATIONS WITH MSFN"
KEYING COMMUNICATIONS TO MSFN	UNIFIED S-BAND SYSTEM						● SEE TABLE 3.5-2B FOR REQUIREMENTS
TELEMETRY TO MSFN	UNIFIED S-BAND SYSTEM						● SEE TABLE 3.5-2B FOR REQUIREMENTS
TO MSFN	VHF TRANSCEIVER #2		VHF				● UTILIZED FOR VOICE AND DATA TRANSMISSION SIMULATION DURING R & D FLIGHT PROGRAM ● SEE "VOICE COMMUNICATIONS WITH LEM"
TO MSFN	PCM/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH TRANSCEIVER #1	PCM/FM NRZ-C SERIAL BIT STREAM	● SEE NOTES 2, 3 AND 5 ● SELECTABLE BIT RATES OF 51.2 KILOBITS/SECOND AND 1.6 KILOBITS/SECOND ● ALSO PROVIDES PLAYBACK OF RECORDED CSM PCM TELEMETRY
TO MSFN	PAM/FM/FM TELEMETER	TWO	225-260 Mc		MULTIPLEXED WITH TRANSCEIVER #1	PAM/FM/FM	● TRANSMITS DATA REQUIRED ONLY FOR POST-FLIGHT ANALYSIS ● SEE NOTE 3
TO MSFN	PAM/FM/FM TELEMETER	ONE	225-260 Mc			PAM/FM/FM	● TRANSMITS DATA REQUIRED ONLY FOR POST-FLIGHT ANALYSIS ● SEE NOTE 3
FROM LEM	VHF TRANSCEIVER #2			VHF		PCM/AM	● SEE "VOICE COMMUNICATIONS WITH LEM" ● SEE NOTE 4 ● PCM BIT RATE OF 1.6 KILOBITS/SECOND
FROM EVA	VHF TRANSCEIVER #2			VHF		FM/AM	● SEE "VOICE COMMUNICATIONS WITH LEM"
TAPE PLAYBACK TO MSFN	UNIFIED S-BAND SYSTEM						● SEE TABLE 3.5-2B FOR REQUIREMENTS
TO MSFN	PCM/FM TELEMETER		225-260 Mc				● SEE "TELEMETRY TO MSFN"
TO MSFN	PCM/FM TELEMETER	ONE	225-260 Mc			PCM/FM	● TRANSMITS RECORDED PCM/FM DATA ● SEE NOTES 2, 3 AND 5
TELEVISION TO MSFN	UNIFIED S-BAND SYSTEM						● SEE TABLE 3.5-2B FOR REQUIREMENTS
UP-DATA (SEE NOTE 6) FROM MSFN	UNIFIED S-BAND SYSTEM						● SEE TABLE 3.5-2B FOR REQUIREMENTS
FROM MSFN	RECEIVER AND DECODER	ONE		400-450 Mc	UTILIZES TRANSCEIVER #1 IN-FLIGHT ANTENNA	PSK/FM	● SUBCODED 5-BIT WORDS AT 1000 BITS/SECOND
TRACKING AID TO MSFN	UNIFIED S-BAND SYSTEM						● SEE TABLE 3.5-2B FOR REQUIREMENTS
TO MSFN	C-BAND RADAR TRANSPONDER	ONE	C-BAND	C-BAND	OMNI-DIRECTIONAL	PULSE	● UTILIZES CODING DIFFERENT FROM LAUNCH VEHICLE AND LEM C-BAND RADAR TRANSPONDERS
TO LEM	RENDEZVOUS RADAR TRANSPONDER	ONE	X-BAND	X-BAND	OMNI-DIRECTIONAL	FM RECEIVE FM TRANSMIT	● THREE TONE RANGE CODE AND CARRIER COHERENT TURN-AROUND
BEACON TO RECOVERY FORCES	VHF BEACON	ONE	VHF		OMNI-DIRECTIONAL	AM	● VHF RECOVERY ANTENNA DEPLOYED AT MAIN CHUTE DEPLOYMENT ● BEACON IS MULTIPLEXED WITH TRANSCEIVER #1 AFTER ENTRY
TO RECOVERY FORCES	HF TRANSCEIVER		HF				● SEE "VOICE COMMUNICATIONS WITH RECOVERY FORCES"
TO RECOVERY FORCES	VHF TRANSCEIVER #1		VHF		MULTIPLEXED WITH VHF BEACON ANTENNA AFTER ENTRY		● SEE "VOICE COMMUNICATIONS WITH MSFN"

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NOTES:

1. THE MINIMUM WORD INTELLIGIBILITY SHALL BE 90% FOR NORMAL VOICE COMMUNICATIONS AND 70% FOR BACK-UP COMMUNICATIONS AS MEASURED BY USER PERSONNEL UNDER SIMULATED OPERATING CONDITIONS UTILIZING THE AMERICAN STANDARD METHOD FOR MEASUREMENT OF MONOSYLLABIC WORD INTELLIGIBILITY DATED MAY 25, 1960.

2. THE TELEMETRY SUBSYSTEM SHALL BE DESIGNED TO PROVIDE AN ERROR RATE NOT EXCEEDING ONE BIT IN 10^6 BITS FOR TRANSMISSIONS TO THE MSFN AS MEASURED FORM CSM ENCODER TO MSFN DECODER.

3. THIS TELEMETRY SUBSYSTEM SHALL BE COMPATIBLE WITH THE INTER RANGE INSTRUMENTATION GROUP STANDARDS (IRIG DOCUMENT NO. 106-60, "TELEMETRY STANDARDS REVISED 1962")

4. THE TELEMETRY SUBSYSTEM SHALL BE DESIGNED TO PROVIDE AN ERROR RATE NOT EXCEEDING ONE BIT IN 10^6 BITS FOR PCM TELEMETRY TRANSMISSION TO THE CSM AS MEASURED FROM LEM ENCODER TO THE CSM RECORDER.

5. THIS PCM TELEMETRY SUBSYSTEM SHALL CAPABLE OF TRANSMITTING THE PCM BIT STREAM REQUIRED FOR REAL-TIME USE VIA COAXIAL CABLE TO THE CHECKOUT FACILITY IN THE MILA PRIOR TO LIFT-OFF AND VIA AN RF LINK PRIOR TO AND AFTER LIFT-OFF.

6. NO MORE THAN ONE CORRECT MESSAGE SHALL BE REJECTED PER 1000 CORRECT MESSAGES AND NO MORE THAN ONE PER 10^9 INCORRECT MESSAGES SHALL BE ACCEPTED.

LEGEND

EQUIPMENT/FUNCTION THIS FLIGHT	EQUIPMENT/FUNCTION LUNAR MISSION	CODING
REQUIRED	REQUIRED	
REQUIRED	NOT REQUIRED	
NOT REQUIRED	REQUIRED	
NOT REQUIRED	NOT REQUIRED	

TABLE 3.5-2A
APOLLO-SATURN 501/502

APPENDIX 501/502

TABLE 3.5-2B

CSM UNIFIED S-BAND COMMUNICATIONS AND TRACKING REQUIREMENTS

APOLLO-SATURN 501/502

SUBSYSTEM	EQUIPMENT IMPLEMENTATION	NUMBER OF UNITS	OPERATING FREQUENCY TRANSMIT	OPERATING FREQUENCY RECEIVE	ANTENNA SUBSYSTEM	MODULATION CHARACTERISTICS	REMARKS
VOICE COMMUNICATIONS (SEE NOTE 1) WITH MSFN	PM TRANSPONDER	TWO	S-BAND	S-BAND	OMNI-DIRECTIONAL DIRECTIONAL - VARIABLE BEAMWIDTH	FM/PM TRANSMIT - 1.25 Mc SUBCARRIER FM/PM RECEIVE 30 Kc SUBCARRIER	● TRANSPONDER FREQUENCY SHALL BE COHERENT WITH SIGNALS RECEIVED FROM THE MSFN AND IN THE RATIO OF 240:221 ● RELAY VOICE AND TELEMETRY COMMUNICATIONS WITH EVA ● BACKUP RELAY OF VOICE COMMUNICATIONS WITH LEM ● TRANSPONDER ALSO PROVIDES FOR TELEMETRY TRANSMISSION, KEYED TRANSMISSION, UP-DATA RECEPTION AND TRACKING ASSISTANCE TO THE MSFN.
						PM TRANSMIT AT BASEBAND	● EMERGENCY VOICE TRANSMISSION ● THIS CAPABILITY IS PROVIDED ONLY WHEN THE CAPABILITY FOR SIMULTANEOUS PM AND FM S-BAND TRANSMISSION IS PROVIDED.
						FM/PM RECEIVE 70 Kc SUBCARRIER	● EMERGENCY VOICE RECEPTION. ● THIS CAPABILITY IS PROVIDED ONLY WHEN THE CAPABILITY FOR SIMULTANEOUS PM AND FM S-BAND TRANSMISSION IS PROVIDED. ● SEE "UP-DATA FROM MSFN"
WITH MSFN	FM TRANSMITTER #1	ONE	S-BAND		MULTIPLEXED WITH S-BAND TRANSPONDER OMNI-DIRECTIONAL ANTENNA SYSTEM	FM/FM TRANSMIT 1.25 Mc SUBCARRIER	● THIS TRANSMITTER OPERATES ON THE SAME FREQUENCY AS THE TRANSPONDER, THEREFORE IT IS PROVIDED ONLY ON THOSE FLIGHTS FOR WHICH SIMULTANEOUS PM AND FM S-BAND TRANSMISSION IS NOT REQUIRED. ● VOICE RECEPTION IS ACHIEVED VIA PM RECEPTION OF 30 Kc FM SUBCARRIER. ● TRANSMITTER ALSO PROVIDES FOR TELEMETRY, SCIENTIFIC DATA, TELEVISION, AND TAPE PLAYBACK TRANSMISSION TO THE MSFN.
KEYING COMMUNICATIONS TO MSFN	PM TRANSPONDER		S-BAND			AM/PM 512 Kc SUBCARRIER	● SEE "VOICE COMMUNICATIONS WITH MSFN" ● TRANSMITTED ALONE - BACKUP FOR VOICE TRANSMISSION
TELEMETRY TO MSFN	PM TRANSPONDER		S-BAND			PCM/PM/PM 1.024 Mc SUBCARRIER NRZ-C SERIAL BIT STREAM	● SEE "VOICE COMMUNICATIONS WITH MSFN" ● SELECTABLE BIT RATES OF 51.2 KILOBITS/SECOND AND 1.6 KILOBITS/SECOND ● SEE NOTES 2 AND 3
						FM/FM/PM 7 SUBCARRIERS ON 1.25 Mc VOICE SUBCARRIER	● SEE "VOICE COMMUNICATIONS WITH MSFN" ● RELAY OF COMPOSITE EVA VOICE AND 7 CHANNELS OF EVA TELEMETRY ON VOICE SUBCARRIER WHEN SIMULTANEOUS PM AND FM S-BAND TRANSMISSION CAPABILITY IS PROVIDED.
TO MSFN	FM TRANSMITTER #1		S-BAND			PCM/PM/FM 1.024 Mc SUBCARRIER NRZ-C SERIAL BIT STREAM	● SEE "VOICE COMMUNICATIONS WITH MSFN" ● SELECTABLE BIT RATES OF 51.2 KILOBITS/SECOND AND 1.6 KILOBITS/SECOND ● SEE NOTES 2 AND 3
						FM/FM 95 Kc, 125 Kc, 165 Kc SUBCARRIERS	● SEE "VOICE COMMUNICATIONS WITH MSFN" ● PROVIDES 3 CHANNELS OF REAL TIME SCIENTIFIC DATA TRANSMISSION TO THE MSFN ● SIX ADDITIONAL SUBCARRIERS ARE ALSO AVAILABLE
TO MSFN	FM TRANSMITTER #2	ONE	S-BAND		MULTIPLEXED WITH S-BAND TRANSPONDER ANTENNA SYSTEM	FM/FM 95 Kc, 125 Kc, 165 Kc SUBCARRIERS	● THIS TRANSMITTER IS PROVIDED ONLY ON THOSE FLIGHTS FOR WHICH SIMULTANEOUS PM AND FM S-BAND TRANSMISSION IS REQUIRED. ● TRANSMITTER ALSO PROVIDES FOR TELEVISION AND TAPE PLAYBACK TRANSMISSION TO THE MSFN. ● PROVIDES 3 CHANNELS OF REAL TIME SCIENTIFIC DATA TRANSMISSION TO THE MSFN
TAPE PLAYBACK TO MSFN	FM TRANSMITTER #1		S-BAND				● SEE "VOICE COMMUNICATIONS WITH MSFN"
						FM/FM 95 Kc, 125 Kc, 165 Kc SUBCARRIERS	● RECORDED SCIENTIFIC DATA - 3 CHANNELS ● SIX ADDITIONAL CHANNELS ARE ALSO AVAILABLE
						FM/FM ANALOG SUBCARRIER	● RECORDED VOICE
						PCM/PM/FM 1.024 Mc SUBCARRIER	● RECORDED CSM PCM TELEMETRY AT APPARENT 51.2 KILOBITS/SECOND RATE
TO MSFN	FM TRANSMITTER #2		S-BAND				● SEE "TELEMETRY TO MSFN"
						FM/FM 95 Kc, 125 Kc, 165 Kc SUBCARRIERS	● RECORDED SCIENTIFIC DATA - 3 CHANNELS
						FM AT BASEBAND	● RECORDED VOICE
						PCM/PM/FM 1.024 Mc SUBCARRIER	● RECORDED CSM PCM TELEMETRY AT APPARENT 51.2 KILOBITS/SECOND
						FM AT BASEBAND	● RECORDED LEM 1.6 KILOBITS/SECOND PCM TELEMETRY AT APPARENT 51.2 KILOBITS/SECOND
TELEVISION TO MSFN	FM TRANSMITTER #1		S-BAND			FM AT BASEBAND	● SEE "VOICE COMMUNICATIONS WITH MSFN"
TO MSFN	FM TRANSMITTER #2		S-BAND			FM AT BASEBAND	● SEE "TELEMETRY TO MSFN"
UP-DATA (SEE NOTE 4) FROM MSFN	PM TRANSPONDER			S-BAND		PSK/FM/PM 70 Kc SUBCARRIER	● SEE "VOICE COMMUNICATIONS WITH MSFN" ● SUBCODED 5-BIT WORDS AT 1000 BITS/SECOND
TRACKING AID TO MSFN	PM TRANSPONDER		S-BAND	S-BAND		PM RECEIVE- PRN CODE AT BASEBAND PM TRANSMIT- PRN CODE AT BASEBAND	● SEE "VOICE COMMUNICATIONS WITH MSFN" ● COHERENT TURN-AROUND CARRIER ● COHERENT TURN-AROUND RANGE CODE

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NOTES:

1. THE MINIMUM WORD INTELLIGIBILITY SHALL BE 90% FOR NORMAL VOICE COMMUNICATIONS AND 70% FOR BACK-UP COMMUNICATIONS AS MEASURED BY USER PERSONNEL UNDER SIMULATED OPERATING CONDITIONS UTILIZING THE AMERICAN STANDARD METHOD FOR MEASUREMENT OF MONOSYLLABIC WORD INTELLIGIBILITY DATED MAY 25, 1960

2. THE TELEMETRY SUBSYSTEM SHALL BE DESIGNED TO PROVIDE AN ERROR RATE NOT EXCEEDING ONE BIT IN 10^6 BITS FOR PCM TELEMETRY TRANSMISSIONS TO STATIONS OF THE MSFN AS MEASURED FROM CSM ENCODER TO MSFN DECODER.

3. THE PCM TELEMETRY SUBSYSTEM SHALL BE CAPABLE OF TRANSMITTING THE PCM BIT STREAM REQUIRED FOR REAL-TIME USE VIA COAXIAL CABLE TO THE CHECKOUT FACILITY IN THE MILA PRIOR TO LIFT-OFF AND VIA AN RF LINK PRIOR TO AND AFTER LIFT-OFF.

4. THE UP-DATA SUBSYSTEM SHALL BE DESIGNED IN CONJUNCTION WITH STATIONS OF THE MSFN SUCH THAT NO MORE THAN ONE CORRECT MESSAGE SHALL BE REJECTED PER 1000 CORRECT MESSAGES AND THAT NO MORE THAN ONE PER 10^9 INCORRECT MESSAGES SHALL BE ACCEPTED.

LEGEND

EQUIPMENT/FUNCTION THIS FLIGHT	EQUIPMENT/FUNCTION LUNAR MISSION	CODING
REQUIRED	REQUIRED	
REQUIRED	NOT REQUIRED	
NOT REQUIRED	REQUIRED	
NOT REQUIRED	NOT REQUIRED	

APPENDIX 501/502
TABLE 3. 7 - 1
REQUIRED SPACECRAFT COVERAGE
APOLLO - SATURN 501/502

SUBSYSTEM \ PHASE	S-IC BURN	S-II BURN	S-IVB BURN	INSERTION + 3 MIN.	ORBIT #1 [1]	ORBIT #2 [1]	ORBIT #3 [1]	ORBIT #4 [1,2]	PRE-INJECTION CHECKOUT [3]	INJECTION BURN -1 TO +3 MIN. [4]	POST INJECTION TO +15 MIN.	CSM SEPARATION	COAST	SPS BURNS	PRE-ENTRY	CM ENTRY
CSM VHF																
SIMULATED VOICE	CONTINOUS	CONTINOUS	CONTINOUS	CONTINOUS	PARTIAL	PARTIAL	PARTIAL	PARTIAL	CONTINOUS	CONTINOUS	NOT REQUIRED	NOT REQUIRED	NOT REQUIRED	NOT REQUIRED	NOT REQUIRED	NOT REQUIRED
TELEMETRY	CONTINOUS	CONTINOUS	CONTINOUS	CONTINOUS	PARTIAL	PARTIAL	PARTIAL	PARTIAL	CONTINOUS	CONTINOUS	NOT REQUIRED	NOT REQUIRED	NOT REQUIRED	NOT REQUIRED	NOT REQUIRED	NOT REQUIRED
CSM UHF																
UP - DATA	CONTINOUS	CONTINOUS	CONTINOUS	CONTINOUS	PARTIAL	PARTIAL	PARTIAL	PARTIAL	CONTINOUS	NOT REQUIRED	NOT REQUIRED	NOT REQUIRED	NOT REQUIRED	NOT REQUIRED	NOT REQUIRED	NOT REQUIRED
CSM C - BAND																
TRACKING	CONTINOUS	CONTINOUS	CONTINOUS	CONTINOUS	PARTIAL	PARTIAL	PARTIAL	PARTIAL	CONTINOUS	NOT REQUIRED	PARTIAL	NOT REQUIRED	NOT REQUIRED	NOT REQUIRED	PARTIAL	PARTIAL
CSM S - BAND																
SIMULATED VOICE	CONTINOUS	CONTINOUS	CONTINOUS	CONTINOUS	PARTIAL	PARTIAL	PARTIAL	PARTIAL	CONTINOUS	CONTINOUS	PARTIAL 5	CONTINOUS	PARTIAL	CONTINOUS	PARTIAL	PARTIAL
TELEMETRY	CONTINOUS	CONTINOUS	CONTINOUS	CONTINOUS	PARTIAL	PARTIAL	PARTIAL	PARTIAL	CONTINOUS	CONTINOUS	PARTIAL 5	CONTINOUS	PARTIAL	CONTINOUS	PARTIAL	PARTIAL
UP - DATA	CONTINOUS	CONTINOUS	CONTINOUS	CONTINOUS	PARTIAL	PARTIAL	PARTIAL	PARTIAL	CONTINOUS	NOT REQUIRED	PARTIAL 5	CONTINOUS	PARTIAL	CONTINOUS	PARTIAL	NOT REQUIRED
TRACKING	CONTINOUS	CONTINOUS	CONTINOUS	CONTINOUS	PARTIAL	PARTIAL	PARTIAL	PARTIAL	CONTINOUS	NOT REQUIRED	PARTIAL 5	CONTINOUS	PARTIAL	CONTINOUS	PARTIAL	PARTIAL
STRUCTURAL TEST UNIT																
VHF TELEMETRY	CONTINOUS	CONTINOUS	CONTINOUS	CONTINOUS	PARTIAL	PARTIAL	PARTIAL	PARTIAL	CONTINOUS	CONTINOUS	NOT REQUIRED	NOT REQUIRED	NOT REQUIRED	NOT REQUIRED	NOT REQUIRED	NOT REQUIRED

3/1/66

1 GAP BETWEEN CONTACTS SHALL BE NO GREATER THAN 1/2 ORBIT. CONTACTS SHALL BE AT LEAST 3 MINUTES LONG.

2 CONTINGENCY ORBIT IF INJECTION NOT ATTEMPTED.

3 THIS REQUIREMENT CAN BE SATISFIED DURING THE ORBITAL CONTACTS BEFORE INJECTION.

4 COVERAGE CAN BE PROVIDED BY AIRCRAFT.

5 CONTINUOUS COVERAGE FOR A MINIMUM OF 8 MINUTES.

PARTIAL
CONTINOUS
NOT REQUIRED

TABLE 3. 7 - 1
APOLLO - SATURN 501/502

APPENDIX 501/502
TABLE 3. 7 - 3
REQUIRED SATURN V LAUNCH VEHICLE COVERAGE
APOLLO - SATURN 501/502

SUBSYSTEM \ PHASE	S-IC BURN	S-II BURN	FIRST S-IVB BURN	INSERTION + 3 MIN	ORBIT #1 [1]	ORBIT #2 [1]	ORBIT #3 [1]	ORBIT #4 [1,2]	PRE-INJECTION CHECKOUT [3]	INJECTION BURN (-1 TO +3 MIN.) [4]	POST INJECTION (TO +15 MIN.)	LAUNCH VEHICLE SEPARATION
TELEMETRY												
S-IC VHF	CONTINUOUS 5											
S-II VHF	CONTINUOUS	CONTINUOUS 5										
S-IVB VHF	CONTINUOUS	CONTINUOUS	CONTINUOUS	CONTINUOUS	PARTIAL	PARTIAL	PARTIAL	PARTIAL	CONTINUOUS	CONTINUOUS		
IU VHF	CONTINUOUS	CONTINUOUS	CONTINUOUS	CONTINUOUS	PARTIAL	PARTIAL	PARTIAL	PARTIAL	CONTINUOUS	CONTINUOUS		
IU S-BAND	CONTINUOUS	CONTINUOUS	CONTINUOUS	CONTINUOUS	PARTIAL	PARTIAL	PARTIAL	PARTIAL	CONTINUOUS	CONTINUOUS	CONTINUOUS 6	CONTINUOUS
IU CCS	CONTINUOUS	CONTINUOUS	CONTINUOUS	CONTINUOUS	PARTIAL	PARTIAL	PARTIAL	PARTIAL	CONTINUOUS	CONTINUOUS	CONTINUOUS 6	CONTINUOUS
UP-DATA												
IU CCS	PARTIAL	PARTIAL	PARTIAL	CONTINUOUS	PARTIAL	PARTIAL	PARTIAL	PARTIAL	CONTINUOUS		PARTIAL	CONTINUOUS
TELEVISION (AS-502 ONLY)												
S-IC	CONTINUOUS 10											
COMMAND DESTRUCT												
S-IC	CONTINUOUS 7											
S-II	CONTINUOUS	PARTIAL 7										
S-IVB	CONTINUOUS	PARTIAL	PARTIAL 7									
TRACKING												
IU CCS	PARTIAL	PARTIAL	PARTIAL	CONTINUOUS	PARTIAL	PARTIAL	PARTIAL	PARTIAL	CONTINUOUS 9		PARTIAL	CONTINUOUS
IU C-BAND	CONTINUOUS 8	CONTINUOUS 8	CONTINUOUS 8	CONTINUOUS	PARTIAL	PARTIAL	PARTIAL	PARTIAL	CONTINUOUS 9		PARTIAL	
AZUSA	PARTIAL 8	PARTIAL 8	PARTIAL									
ODOP	PARTIAL 8											

3/1/66

1 GAP BETWEEN CONTACTS SHALL BE NO GREATER THAN 1/2 ORBIT. CONTACTS SHALL BE AT LEAST 3 MINUTES LONG.

2 CONTINGENCY ORBIT IF INJECTION NOT ATTEMPTED.

3. THIS REQUIREMENT CAN BE SATISFIED DURING THE ORBITAL CONTACTS BEFORE INJECTION.

4 COVERAGE CAN BE PROVIDED BY AIRCRAFT.

5 COVERAGE SHALL CONTINUE FOR AT LEAST ONE MINUTE AFTER THE END OF BURN.

6 CONTINUOUS COVERAGE FOR A MINIMUM OF 8 MINUTES.

7 CONTINUOUS COVERAGE UNTIL THE PREDICTED IMPACT POINT OF THE VEHICLE IS OUTSIDE AREAS SPECIFIED BY RANGE SAFETY.

8 TWO LAUNCH VEHICLE TRANSPONDERS SHALL BE TRACKED CONTINUOUSLY TO SATISFY RANGE REQUIREMENTS.

9 THIS REQUIREMENT CAN BE SATISFIED BY EITHER IU CCS OR IU C-BAND

10 TELEVISION TRANSMISSION SHALL BE RECEIVED BY THE CENTRAL INSTRUMENTATION FACILITY IN THE LAUNCH AREA.

PARTIAL COVERAGE
CONTINUOUS COVERAGE
NOT REQUIRED

TABLE 3. 7 - 3
APOLLO - SATURN 501/502

Apollo Saturn Mission 503

1.0 Scope This appendix to the Apollo Program Specification identifies the performance, design and test requirements which apply to the Program elements to be utilized for Apollo Saturn Mission 503 (AS-503). These requirements are presented in this appendix as deviations to the requirements specified in the body of the specification. Unless otherwise noted, the paragraphs in this appendix replace in their entirety the identically numbered paragraphs in the body of the specification.

1.1 Applicability No change.[1]

1.2 Change Approval No change.

2.0 Applicable Documents No change.

3.0 Requirements

3.1 Performance

3.1.1 Characteristics

3.1.1.1 General Add: To the extent practicable, the hardware used on AS-503 shall be of the same design as that to be used for the lunar landing mission.

3.1.1.2 Mission Performance

3.1.1.2.1 Mission Mode For this mission the Saturn V launch vehicle, consisting of an S-IC first stage, an S-II second stage, an S-IVB third stage, and an Instrument Unit (IU) shall launch the spacecraft

(1) The phrase "no change" is used after each section heading throughout this appendix to mean that the requirement in the body of the specification applies to this mission without change.

Apollo Saturn Mission 503

from the Cape Kennedy launch area (LC 39B) and propel it through an Earth parking orbit phase into an elliptical trajectory. The manned spacecraft, which includes a CM, SM, and a LEM, shall utilize the spacecraft propulsion systems for maneuvering after injection into the elliptical trajectory and for return to a circular Earth parking orbit. After Earth parking orbit operations, the SPS shall be used to reduce the spacecraft velocity sufficiently for entry. The SM shall be jettisoned prior to entry of the CM into the Earth's atmosphere. The CM shall be slowed to a safe landing by aerodynamic braking and, during the final phases of the landing sequence, by parachute. This mission shall simulate, to the greatest practicable degree, the lunar landing mission.

3.1.1.2.2 Mission Command No change.

3.1.1.2.3 Payload The payload for this mission shall include a manned spacecraft. The objectives of this mission shall include those identified in Apollo Flight Mission Assignments, M-D MA 500-11.

3.1.1.2.4 Earth Launch Launch capability shall be provided to permit an initial flight azimuth of 072°.

3.1.1.2.5 Earth Parking Orbit No change.

3.1.1.2.6 Injection Opportunities Change "a lunar transfer" to "an elliptical."

3.1.1.2.7 Lunar Landing Accuracy No change.

3.1.1.2.8 Lunar Exploration Not applicable. N/A.[2]

(2) The phrase "not applicable" is used after a section heading throughout this appendix to mean that the requirement in the body of the specification does not apply to this mission.

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3.1.1.2.9 Earth Landing The normal Earth landing mode shall be on water. The capability for water and land landing shall be as specified in 3.5.1.24.

3.1.1.2.10 Recovery No change.

3.1.2 Program Definition No change.

3.1.3 Operability

3.1.3.1 Logistics No change.

3.1.3.2 Safety No change.

3.1.3.3 Reliability

3.1.3.3.1 Equipment Reliability No change.

3.1.3.3.2 Environmental Hazards Change "the lunar landing mission" to "this mission" and delete reference to the lunar surface.

3.1.3.3.3 Crew Safety No change.

3.1.3.3.4 System Design Policy No change.

3.1.3.3.5 Reliability Assurance No change.

3.2 Program Standards No change.

3.3 Saturn IB Launch Vehicle N/A.

3.4 Saturn V Launch Vehicle

3.4.1 General No change except the launch vehicle control weights shall be as specified for AS-503 in Table 10.1-2, Appendix 10.1.

3.4.1.1 Payload The launch vehicle shall provide the payload capability specified for AS-503 in Table 10.1-2, Appendix 10.1.

Apollo Saturn Mission 503

3.4.1.2 Standby Time The launch vehicle shall have the capability to stand by in a loaded condition with propellant topping for 12 hours and still perform the mission.

3.4.1.3 Prelaunch Checkout No change.

3.4.1.4 In-Flight Performance Evaluation No change.

3.4.1.5 Emergency Detection Subsystem (EDS) No change.

3.4.1.6 Instrumentation No change.

3.4.1.7 Command Destruct No change.

3.4.1.8 Electrical Power No change.

3.4.1.9 Attitude Control Change "translunar" to "elliptical."

3.4.2 Structure No change.

3.4.3 Propulsion No change except each S-II stage J-2 engine vacuum thrust shall be 200,000 ± 6,000 pounds. S-IVB J-2 engine vacuum thrust shall be 205,000 ± 6,150 pounds. Each F-1 engine shall provide a sea level thrust of $1,500,000\ {}^{+45,000}_{-0}$ pounds.

3.4.4 Guidance, Navigation and Control No change except in 3.4.4.1.2 (c) change "translunar" to "elliptical trajectory."

3.4.5 Saturn V Vehicle Communications and Tracking

3.4.5.1 General Add: (e) Television transmission.

3.4.5.2 Functional Capability Add the following paragraph:

3.4.5.2.5 Television The television subsystem on the S-IC stage shall provide television coverage of S-IC/S-II separation to the Central Instrumentation Facility.

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3.4.5.3 Coverage Capability The Saturn V Communication and Tracking System shall be able to operate with the MSFN to achieve the coverage specified in Table 3.7-3 (503) of this appendix.

3.4.5.4 Performance The Saturn V Communication and Tracking System shall meet the requirements specified in Table 3.4-1 (503) of this appendix. The Command and Communication System (CCS) in the IU, which operates at the same frequencies as the Unified S-Band (USB) subsystem in the LEM, shall be capable of being deactivated after separation of the spacecraft from the launch vehicle. VHF telemeters on board the launch vehicle shall be inoperative when spacecraft communications systems utilizing the same frequencies are operated.

3.5 Spacecraft

3.5.1 General No change except that spacecraft control weights shall be as specified for AS-503 in Table 10.1-4, Appendix 10.1. Delete reference to ΔV budget.

3.5.1.1 Prelaunch Environment No change.

3.5.1.2 Prelaunch Checkout No change.

3.5.1.3 In-Flight Performance Evaluation No change.

3.5.1.4 Standby Time The spacecraft shall have the capability to stand by in a loaded condition, after launch vehicle propellant loading, for 10 hours and still perform the mission.

3.5.1.5 Launch and Flight Environment No change.

3.5.1.6 Earth Orbit Environment No change.

3.5.1.7 Translunar Environment N/A. See 3.1.1.1 (AS-503).

3.5.1.8 Transposition No change.

3.5.1.9 One-Man Operation Delete reference to lunar operations.

3.5.1.10 CSM/LEM Abort No change.

Apollo Saturn Mission 503

3.5.1.11 Separation Time No change.

3.5.1.12 Descent Abort N/A.

3.5.1.13 Translational Range N/A.

3.5.1.14 Lunar Environment N/A. See 3.1.1.1 (AS-503).

3.5.1.15 Lunar Landing N/A. See 3.1.1.1 (AS-503).

3.5.1.16 Lunar Operations The LEM shall be capable of accommodating the temperature of lunar day as given in 5.7 of M-DE 8020.008B.

3.5.1.17 Scientific Equipment Support See 3.5.7 (AS-503).

3.5.1.18 Sterilization No change.

3.5.1.19 Launch Platform N/A.

3.5.1.20 Ascent Stage Operations Using the LEM Ascent Propulsion Subsystem, the ascent stage shall be capable of separating from the descent stage. The ascent stage shall be capable of operation independent of the descent stage for at least the time necessary to achieve the objectives specified in 3.1.1.2.3 (AS-503).

3.5.1.21 Rendezvous and Dock Change "lunar" to "Earth."

3.5.1.22 Entry The CM shall be capable of controlled flight through the Earth's atmosphere (as given in 2.5 of M-DE 8020.008B) to a preselected water landing area. This shall be possible without exceeding a 10g deceleration for an Earth orbital entry. The design limit entry load for all CM systems shall be a 20g deceleration.

3.5.1.23 Aerodynamic Characteristics No change.

3.5.1.24 Landing No change.

3.5.1.25 Postlanding No change.

3.5.1.26 Recovery No change.

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3.5.2 Command and Service Modules

3.5.2.1 Structure No change.

3.5.2.2 CSM Propulsion

3.5.2.2.1 General No change except that ΔV numbers in Table 3.5-1 are not applicable.

3.5.2.2.2 Command Module Reaction Control Subsystem No change.

3.5.2.2.3 Service Module Reaction Control Subsystem No change.

3.5.2.2.4 Service Module Propulsion Subsystem No change.

3.5.2.3 CSM Communications and Tracking

3.5.2.3.1 General No change.

3.5.2.3.2 Functional Capability No change.

3.5.2.3.3 Coverage Capability

3.5.2.3.3.1 CSM-MSFN The CSM Communication and Tracking System shall be able to operate with the MSFN to achieve the coverage specified in Table 3.7-1 (503) of this appendix.

3.5.2.3.3.2 CSM-LEM No change.

3.5.2.3.3.3 CSM-EVA No change.

3.5.2.3.4 Performance No change except that a C-Band Radar Transponder, utilizing an omni-directional antenna subsystem and pulse modulation shall also be carried. Interrogation coding differing from the launch vehicle and LEM radar transponders shall be utilized.

3.5.2.4 Electrical Power Subsystem

3.5.2.4.1 General Change "during translunar and lunar orbit phases" to "while docked."

3.5.2.4.2 Nominal Capacity No change.

3.5.2.4.3 Sizing No change.

3.5.2.4.4 Water and Oxygen Supply No change.

3.5.2.4.5 Pyrotechnic Firing Circuit No change.

3.5.2.4.6 Ground Support No change.

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3.5.2.5 Integrated Navigation, Guidance and Control System

3.5.2.5.1 General No change.

3.5.2.5.1.1 No change.

3.5.2.5.1.2 No change.

3.5.2.5.1.3 No change.

3.5.2.5.1.4 No change

3.5.2.5.1.5 The PNGCS shall:

(a) Delete "and lunar landmarks."

(b) No change.

(c) No change.

(d) Change "lunar" to "Earth."

(e) No change.

(f) No change.

3.5.2.5.2 Accuracy No change.

3.5.2.6 Display and Control Subsystem No change.

3.5.2.7 Environmental Control Subsystem No change.

3.5.2.8 Crew Equipment No change.

3.5.3 Lunar Excursion Module

3.5.3.1 Structure

3.5.3.1.1 Cabin Space No change.

3.5.3.1.2 Windows Delete "and lunar landing."

3.5.3.1.3 Ingress and Egress Delete (c).

3.5.3.1.4 Docking No change.

3.5.3.1.5 Thermal Requirements No change.

3.5.3.1.6 EMU Storage No change.

3.5.3.2 LEM Propulsion

3.5.3.2.1 General No change except that ΔV numbers in Table 3.5-1 are not applicable.

Apollo Saturn Mission 503

3.5.3.2.2 LEM Reaction Control Subsystem The LEM RCS shall provide thrust for translation along three axes and attitude control about three axes during rendezvous, docking, descent engine and ascent engine operations. There shall be two separate, redundant subsystems. Propellant shall be transferable from the LEM ascent stage main propellant tanks to the LEM RCS engines during flight.

3.5.3.2.3 LEM Descent Propulsion Subsystem The LEM Descent Propulsion Subsystem shall provide the propulsion and propulsion control necessary to support the mission objectives of 3.1.1.2.3 (AS-503).

3.5.3.2.4 LEM Ascent Propulsion Subsystem The LEM Ascent Propulsion Subsystem shall provide the propulsion necessary to support the mission objectives of 3.1.1.2.3 (AS-503). It shall be capable of providing the propulsion required to return the LEM ascent stage to the CSM.

3.5.3.3 LEM Communications and Tracking

3.5.3.3.1 General Add: (e) Up-data reception.

3.5.3.3.2 Functional Capability

3.5.3.3.2.1 Voice Communication No change.

3.5.3.3.2.2 Telemetry Add: (e) Transmit the data required for post-flight analysis.

3.5.3.3.2.3 Tracking and Tracking Aid Delete (c).

3.5.3.3.2.4 Television Delete "from the lunar surface."

3.5.3.3.2.5 Up-Data The up-data subsystem shall be able to:

(a) Receive data from the MSFN.

(b) Supply up-data verification signals to the MSFN via the LEM telemetry subsystem.

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3.5.3.3.3 Coverage Capability

3.5.3.3.3.1 LEM-MSFN The LEM Communication and Tracking System shall be able to operate with the MSFN to achieve the coverage specified in Table 3.7-2 (503) of this appendix.

3.5.3.3.3.2 LEM-CSM No change.

3.5.3.3.3.3 LEM-EVA Delete reference to the lunar surface.

3.5.3.3.3.4 LEM-Lunar Surface N/A.

3.5.3.3.4 Performance The LEM Communication and Tracking System shall meet the requirements specified in Tables 3.5-4A (503) and 3.5-4B (503) of this appendix.

3.5.3.4 Electrical Power Subsystem

3.5.3.4.1 General Change "during the translunar and lunar orbit phases" to "while docked." Delete the last sentence.

3.5.3.4.2 Sizing Delete: "in lunar orbit."

3.5.3.4.3 Nominal Capacity No change.

3.5.3.4.4 Pyrotechnic Firing Circuits No change.

3.5.3.4.5 Ground Support No change.

3.5.3.5 Integrated Navigation, Guidance and Control System

3.5.3.5.1 General No change except in the last paragraph, change "lunar parking orbit" to "the CSM."

3.5.3.5.1.1 No change.

3.5.3.5.1.2 No change.

3.5.3.5.1.3 No change.

3.5.3.5.1.4 The PNGCS shall:

(a) No change.

(b) N/A.

(c) N/A.

(d) Delete reference to the lunar surface.

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(e) N/A.

(f) No change.

(g) No change.

(h) Provide for prelaunch alignment of the PNGCS IMU.

3.5.3.5.2 Accuracy N/A. See 3.1.1.1 (AS-503).

3.5.3.6 Display and Control (D&C) Subsystem No change.

3.5.3.7 Environmental Control Subsystem No change.

3.5.3.7.1 Extravehicular Operations No change.

3.5.3.7.2 Atmospheric Supply No change.

3.5.3.7.3 Water Management No change.

3.5.3.7.4 EMU Support Change "requirements of 3.5.1.20" to "mission objectives of 3.1.1.2.3 (AS-503)."

3.5.3.8 Crew Equipment No change.

3.5.4 Launch Escape System No change.

3.5.5 Adapter No change.

3.5.6 Extravehicular Mobility Unit

3.5.6.1 General Change "in 3.1.1.2.8" to "of this mission."

3.5.6.2 Extravehicular Delete "or on the lunar surface" and the reference to 5.0 of M-DE 8020.008B.

3.5.6.3 Intravehicular No change.

3.5.7 Scientific Payload The spacecraft shall be capable of supporting the in-flight experiments identified in Apollo Flight Mission Assignments, M-D MA 500-11.

3.5.8 Flight Crew Training Equipment No change.

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Apollo Saturn Mission 503

3.6 Launch Area

3.6.1 General No change.

3.6.2 Space Vehicle Checkout Systems No change.

3.6.3 Launch Complexes 34 and 37B N/A.

3.6.4 Launch Complex 39 No change.

3.6.5 Direct Launch Support Facilities

3.6.5.1 Operations and Checkout Building No change.

3.6.5.2 Central Instrumentation Facility Add: (f) Receiving and recording television signals from the S-IC stage.

3.6.5.3 Central Telephone Office No change.

3.7 Manned Space Flight Network

3.7.1 General No change.

3.7.2 Functional Capability

3.7.2.1 Voice Communications No change.

3.7.2.2 Telemetry No change.

3.7.2.3 Tracking No change.

3.7.2.4 Digital Command Communications The Digital Command Communications Subsystem (DCCS) shall be able to:

(a) Transmit up-data sequentially to the CSM, LEM and the IU.

(b) No change.

(c) Receive from the telemetry subsystem verification of accurate receipt of up-data at the CSM, LEM and the IU.

(d) Transmit verification signals received from the CSM, LEM and the IU to the MCC.

(e) No change.

3.7.2.5 Television No change.

3.7.2.6 Display and Control No change.

3.7.2.7 Data Processing No change.

3.7.2.8 Timing No change.

3.7.3 Coverage Capability The MSFN station in the launch area shall be able to support the prelaunch checkout of the space vehicle on the launch pad.

The MSFN shall provide the coverage capabilities for:

(a) CSM as specified in Table 3.7-1 (503) of this appendix.

(b) LEM as specified in Table 3.7-2 (503) of this appendix.

(c) Saturn V launch vehicle as specified in Table 3.7-3 (503) of this appendix.

3.7.4 Performance No change except the MSFN shall operate with the space vehicle subsystems as specified in 3.4.5, 3.5.2.3 and 3.5.3.3 of this appendix.

3.8 Mission Control Center No change.

4.0 Quality Assurance No change.

APPENDIX 503

TABLE 3. 4 - 1

SATURN V LAUNCH VEHICLE COMMUNICATIONS AND TRACKING REQUIREMENTS

APOLLO - SATURN 503

STAGE	SUBSYSTEM	EQUIPMENT IMPLEMENTATION	NUMBER OF UNITS	OPERATING FREQUENCY TRANSMIT	OPERATING FREQUENCY RECEIVE	ANTENNA SUBSYSTEM	MODULATION CHARACTERISTICS	REMARKS
S - IC	TELEMETRY	PCM/FM TELEMETER	ONE	225-260 Mc		OMNI-DIRECTIONAL	PCM/FM	• SEE NOTES 1, 2 AND 3 • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND
		FM/FM TELEMETER	ONE	225-260 Mc		SEE NOTE 5	FM/FM	• SEE NOTES 1 AND 4 • PAM/FM/FM MODULATION UTILIZED DURING R & D FLIGHT PROGRAM
		PAM/FM/FM TELEMETER	TWO	225-260 Mc		SEE NOTE 5	PAM/FM/FM	• SEE NOTES 1 AND 4
		SS/FM TELEMETER	TWO	225-260 Mc		SEE NOTE 5	SS/FM	• SEE NOTE 4
	COMMAND DESTRUCT	RECEIVER AND DECODER	TWO		400-450 Mc	OMNI-DIRECTIONAL		• THIS SYSTEM SHALL BE COMPATIBLE WITH RANGE SAFETY COMMAND TRANSMITTERS INSTALLED AT STATIONS OF THE ETR
	TRACKING	ODOP TRANSPONDER	ONE	UHF	UHF	FIXED DIRECTIONAL		
	TELEVISION	TELEVISION TRANSMITTER	ONE	1700-1730 Mc				
S - II	TELEMETRY	PCM/FM TELEMETER	ONE	225-260 Mc		OMNI-DIRECTIONAL	PCM/FM	• SEE NOTES 1, 2 AND 3 • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND
		FM/FM TELEMETER	TWO	225-260 Mc		SEE NOTE 5	FM/FM	• SEE NOTES 1 AND 4 • PAM/FM/FM MODULATION UTILIZED DURING R & D FLIGHT PROGRAM
		PAM/FM/FM TELEMETER	ONE	225-260 Mc		SEE NOTE 5	PAM/FM/FM	• SEE NOTES 1 AND 4
		SS/FM TELEMETER	TWO	225-260 Mc		SEE NOTE 5	SS/FM	• SEE NOTE 4
	COMMAND DESTRUCT	RECEIVER AND DECODER	TWO		400-450 Mc	OMNI-DIRECTIONAL		• THIS SYSTEM SHALL BE COMPATIBLE WITH RANGE SAFETY COMMAND TRANSMITTERS INSTALLED AT STATIONS OF THE ETR
S - IVB	TELEMETRY	PCM/FM TELEMETER	ONE	225-260 Mc		OMNI-DIRECTIONAL	PCM/FM	• SEE NOTES 1, 2 AND 3 • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND
		FM/FM TELEMETER[6]	ONE	225-260 Mc		SEE NOTE 5	FM/FM	• SEE NOTES 1 AND 4 • PAM/FM/FM MODULATION UTILIZED DURING R & D FLIGHT PROGRAM
		PAM/FM/FM TELEMETER	TWO	225-260 Mc		SEE NOTE 5	PAM/FM/FM	• SEE NOTES 1 AND 4
		SS/FM TELEMETER	ONE	225-260 Mc		SEE NOTE 5	SS/FM	• SEE NOTE 4
	COMMAND DESTRUCT	RECEIVER AND DECODER	TWO		400-450 Mc	OMNI-DIRECTIONAL		• THIS SYSTEM SHALL BE COMPATIBLE WITH RANGE SAFETY COMMAND TRANSMITTERS INSTALLED AT STATIONS OF THE ETR
INSTRUMENT UNIT	TELEMETRY	PCM/FM TELEMETER	ONE	225-260 Mc		OMNI-DIRECTIONAL	PCM/FM	• SEE NOTES 1, 2 AND 3 • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND • THE TELEMETRY SHALL CONTAIN ALL S-IVB/IU MISSION CONTROL DATA
		PCM/FM TELEMETER	ONE	S-BAND		FIXED DIRECTIONAL VARIABLE BEAMWIDTH	PCM/FM	• SEE NOTES 1 AND 2 • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND • TRANSMITS THE SAME BIT STREAM AS THE IU VHF PCM/FM TELEMETER
		FM/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF IU VHF PCM/FM TELEMETER	FM/FM	• SEE NOTES 1 AND 4
		PAM/FM/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF IU VHF PCM/FM TELEMETER	PAM/FM/FM	• SEE NOTES 1 AND 4
		SS/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF IU VHF PCM/FM TELEMETER	SS/FM	• SEE NOTES 4
		COMMAND AND COMMUNICATION SYSTEM (CCS)	ONE	S-BAND		MULTIPLEXED WITH OUTPUT OF IU S-BAND PCM/FM TELEMETER	PCM/PM/PM	• THIS SYSTEM SHALL PROVIDE TELEMETRY TRANSMISSION, UP-DATA RECEPTION AND TRACKING ASSISTANCE TO THE MSFN • UTILIZES SAME OPERATING FREQUENCIES AS THE LEM USB SYSTEM • SEE NOTE 2 • THE CCS TRANSMITS THE SAME BIT STREAM AS THE S-IVB VHF PCM/FM TELEMETER AT A BIT RATE OF 72 KILOBITS/SECOND
	UP - DATA	CCS			S-BAND		PSK/FM/PM SUBCODED 5-BIT WORDS AT 1000 BITS/SECOND	• NO MORE THAN ONE CORRECT MESSAGE SHALL BE REJECTED PER 1000 CORRECT MESSAGES AND NO MORE THAN ONE PER 10^9 INCORRECT MESSAGES SHALL BE ACCEPTED
	TRACKING AID	CCS		S-BAND	S-BAND		PM	• TRANSMITTED FREQUENCY SHALL BE IN THE RATIO OF 240:221 TO THE RECEIVED FREQUENCY • COHERENT TURN-AROUND CARRIER • COHERENT TURN-AROUND RANGE CODE
		C-BAND RADAR TRANSPONDER	ONE	C-BAND	C-BAND	OMNI-DIRECTIONAL	PULSE	• UTILIZES CODING DIFFERENT FROM C-BAND RADAR TRANSPONDERS ON SPACECRAFT
		AZUSA TRANSPONDER	ONE	C-BAND	C-BAND	OMNI-DIRECTIONAL	FM	

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NOTES:

1. THIS TELEMETRY SUBSYSTEM SHALL BE COMPATIBLE WITH THE INTER RANGE INSTRUMENTATION GROUP STANDARDS (IRIG DOCUMENT NO. 106-60 "TELEMETRY STANDARDS REVISED 1962").

2. ALL PCM TELEMETRY SUBSYSTEMS SHALL BE DESIGNED TO PROVIDE AN ERROR RATE NOT EXCEEDING ONE IN 10^6 BITS FOR TRANSMISSIONS TO THE MSFN AS MEASURED FROM LAUNCH VEHICLE ENCODER TO EARTH-BASED DECODER.

3. THIS PCM/FM TELEMETRY SUBSYSTEM SHALL TRANSMIT THE PCM BIT STREAM REQUIRED FOR REAL-TIME USE VIA COAXIAL CABLE TO THE CHECKOUT FACILITY IN THE MILA PRIOR TO LIFT-OFF AND VIA AN RF LINK PRIOR TO AND AFTER LIFT-OFF.

4. THIS TELEMETRY SUBSYSTEM SHALL TRANSMIT DATA REQUIRED ONLY FOR POST-MISSION ANALYSIS VIA AN RF LINK.

5. UP TO 4 VHF STAGE TELEMETERS SHALL BE MULTIPLEXED ON A COMMON ANTENNA SUBSYSTEM. WHEN MORE THAN 4 VHF STAGE TELEMETERS ARE CARRIED, A SECOND OMNI-DIRECTIONAL ANTENNA SUBSYSTEM SHALL BE PROVIDED.

6. NOT PRESENTLY SCHEDULED FOR OPERATIONAL SATURN V LAUNCH VEHICLES. HOWEVER, PROVISIONS TO CARRY THIS TELEMETER SHALL BE INCORPORATED ON ALL SATURN V LAUNCH VEHICLES THROUGH AS-506.

LEGEND

EQUIPMENT/FUNCTION THIS FLIGHT	EQUIPMENT/FUNCTION LUNAR MISSION	CODING
REQUIRED	REQUIRED	
REQUIRED	NOT REQUIRED	
NOT REQUIRED	REQUIRED	
NOT REQUIRED	NOT REQUIRED	

APPENDIX 503
TABLE 3. 5 - 4A
LEM COMMUNICATIONS AND TRACKING REQUIREMENTS
APOLLO-SATURN 503

SUBSYSTEM	EQUIPMENT IMPLEMENTATION	NUMBER OF UNITS	OPERATING FREQUENCY TRANSMIT	OPERATING FREQUENCY RECEIVE	ANTENNA SUBSYSTEM	MODULATION CHARACTERISTICS	REMARKS
VOICE COMMUNICATIONS (SEE NOTE 1) WITH MSFN	UNIFIED S-BAND SYSTEM						• SEE TABLE 3.5-4B FOR REQUIREMENTS
WITH MSFN	VHF TRANSCEIVER #1		VHF				• UTILIZED FOR VOICE TRANSMISSION SIMULATION DURING R & D FLIGHT PROGRAM • SEE "VOICE COMMUNICATIONS WITH CSM"
WITH MSFN	VHF TRANSCEIVER #2		VHF	VHF			• UTILIZED FOR VOICE AND DATA TRANSMISSION DURING R & D FLIGHT PROGRAM • SEE "VOICE COMMUNICATIONS WITH CSM"
WITH CSM	VHF TRANSCEIVER #1	ONE	VHF	VHF	OMNI-DIRECTIONAL	DSBAM TRANSMIT DSBAM RECEIVE	• PRIMARY VOICE COMMUNICATIONS CHANNEL WITH CSM VIA SIMPLEX MODE • TRANSMITTER UTILIZED FOR DUPLEX VOICE COMMUNICATIONS WITH EVA • TRANSCEIVER UTILIZED IN BACK-UP MODE FOR SIMPLEX VOICE COMMUNICATIONS WITH EVA
WITH CSM	VHF TRANSCEIVER #2	ONE	VHF	VHF	MULTIPLEXED WITH TRANSCEIVER #1	DSBAM TRANSMIT DSBAM RECEIVE	• BACK-UP VOICE COMMUNICATIONS CHANNEL WITH CSM VIA SIMPLEX MODE • TRANSMITS LEM PCM/AM DATA TO CSM • RECEIVER UTILIZED FOR DUPLEX VOICE COMMUNICATIONS WITH EVA • RECEIVES EVA BIOMEDICAL DATA SIMULTANEOUSLY WITH EVA VOICE • TRANSCEIVER UTILIZED IN BACK-UP MODE FOR SIMPLEX VOICE COMMUNICATIONS WITH EVA
WITH EVA	VHF TRANSCEIVER #1		VHF	VHF			• SEE "VOICE COMMUNICATIONS WITH CSM"
WITH EVA	VHF TRANSCEIVER #2		VHF	VHF			• SEE "VOICE COMMUNICATIONS WITH CSM"
KEYING COMMUNICATIONS TO MSFN	UNIFIED S-BAND SYSTEM						• SEE TABLE 3.5-4B FOR REQUIREMENTS
TELEMETRY TO MSFN	UNIFIED S-BAND SYSTEM						• SEE TABLE 3.5-4B FOR REQUIREMENTS
TO MSFN	VHF TELEMETER	ONE	225-260 Mc		R & D OMNI-DIRECTIONAL SUBSYSTEM ON LEM AND CM ADAPTER	PAM/FM/FM	• SEE NOTE 3
TO MSFN	VHF TELEMETER	ONE	225-260 Mc		MULTIPLEXED ON VHF R & D TELEMETRY ANTENNA SUB-SYSTEM	PAM/FM/FM	• SEE NOTE 3
TO MSFN	VHF TELEMETER	ONE	225-260 Mc		MULTIPLEXED ON VHF R & D TELEMETRY ANTENNA SUB-SYSTEM	PAM/FM/FM	• SEE NOTE 3
TO MSFN	VHF TELEMETER	ONE	225-260 Mc		MULTIPLEXED ON VHF R & D TELEMETRY ANTENNA SUB-SYSTEM	FM/FM	• CONSTANT BANDWIDTH SYSTEM
TO MSFN	VHF TELEMETER	ONE	225-260 Mc		MULTIPLEXED ON VHF R & D TELEMETRY ANTENNA SUB-SYSTEM	PCM/FM	• SEE NOTES 2, 3, AND 4 • REDUNDANT WITH UNIFIED S-BAND SYSTEM PCM LINK
TO MSFN	VHF TRANSCEIVER #2		VHF				• UTILIZED FOR DATA TRANSMISSION SIMULATION DURING R & D PROGRAM • SEE "VOICE COMMUNICATIONS WITH CSM"
TO CSM	VHF TRANSCEIVER #2		VHF			PCM/AM	• SEE NOTE 5 • PCM BIT RATE OF 1.6 KILOBITS/SECOND • SEE "VOICE COMMUNICATIONS WITH CSM"
FROM EVA	VHF TRANSCEIVER #2			VHF		FM/AM	• SEE "VOICE COMMUNICATIONS WITH CSM"
TAPE PLAYBACK TO MSFN							• NOT APPLICABLE
TELEVISION TO MSFN	UNIFIED S-BAND SYSTEM						• SEE TABLE 3.5-4B FOR REQUIREMENTS
UP - DATA (SEE NOTE 6) FROM MSFN	RECEIVER AND DECODER	ONE		400-450 Mc	UTILIZES VHF R & D TELEMETRY ANTENNA SUBSYSTEM	PSK/FM	• UTILIZED ONLY DURING R & D FLIGHT PROGRAM
TRACKING AID TO MSFN	UNIFIED S-BAND SYSTEM						• SEE TABLE 3.5-4B FOR REQUIREMENTS
TO MSFN	C-BAND RADAR TRANSPONDER	TWO	C-BAND	C-BAND	OMNI-DIRECTIONAL	PULSE	• SAME CODING IS UTILIZED FOR BOTH TRANSPONDERS BUT CODING DIFFERS FROM THAT USED BY CSM AND LAUNCH VEHICLE
TRACKING OF CSM	RENDEZVOUS RADAR	TWO	X-BAND	X-BAND	DIRECTIONAL	FM TRANSMIT FM RECEIVE	• THREE-TONE RANGE CODE AND CARRIER COHERENT TURN-AROUND • ACCURACY: (a) VELOCITY 1/4% OR 1 fps (b) RANGE 1% OR 20 feet (c) ANGLE 8mr bias 2mr random • ALSO USED FOR TRACKING OF TRACKING AID ON LUNAR SURFACE
OF TRACKING AID ON LUNAR SURFACE	RENDEZVOUS RADAR		X-BAND	X-BAND			• SEE "TRACKING OF CSM"
OF LUNAR SURFACE	LANDING RADAR	ONE	X-BAND	X-BAND	DIRECTIONAL	CW AND FM/CW TRANSMIT	• ACCURACY: (a) VELOCITY 1% OR 1 fps (b) RANGE 1% OR 5 feet

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NOTES:

1. THE MINIMUM WORD INTELLIGIBILITY SHALL BE 90% FOR NORMAL VOICE COMMUNICATIONS AND 70% FOR BACK-UP COMMUNICATIONS AS MEASURED BY USER PERSONNEL UNDER SIMULATED OPERATING CONDITIONS UTILIZING THE AMERICAN STANDARD METHOD FOR MEASUREMENT OF MONOSYLLABIC WORD INTELLIGIBILITY DATED MAY 25, 1960.

2. THE TELEMETRY SUBSYSTEM SHALL BE DESIGNED TO PROVIDE AN ERROR RATE NOT EXCEEDING ONE BIT IN 10^6 BITS FOR PCM TELEMETRY TRANSMISSIONS TO STATIONS OF THE MSFN AS MEASURED FROM LEM ENCODER TO MSFN DECODER.

3. THE TELEMETRY SUBSYSTEMS SHALL BE COMPATIBLE WITH THE INTER RANGE INSTRUMENTATION GROUP STANDARDS (IRIG DOCUMENT NO. 106-60 "TELEMETRY STANDARDS REVISED 1962") APPROPRIATE TO THE RESPECTIVE TELEMETRY SUBSYSTEMS.

4. THIS PCM TELEMETRY SUBSYSTEM SHALL BE CAPABLE OF TRANSMITTING THE PCM BIT STREAM REQUIRED FOR REAL-TIME USE VIA COAXIAL CABLE TO THE CHECKOUT FACILITY IN THE MILA PRIOR TO LIFT-OFF AND VIA AN RF LINK AFTER ADAPTER JETTISON.

5. THE TELEMETRY SUBSYSTEM SHALL BE DESIGNED TO PROVIDE AN ERROR RATE NOT EXCEEDING ONE BIT IN 10^6 BITS FOR PCM TELEMETRY TRANSMISSIONS TO THE CSM AS MEASURED FROM LEM ENCODER TO CSM RECORDER.

6. NO MORE THAN ONE CORRECT MESSAGE SHALL BE REJECTED PER 1000 CORRECT MESSAGES AND THAT NO MORE THAN ONE PER 10^8 INCORRECT MESSAGES SHALL BE ACCEPTED.

LEGEND

EQUIPMENT/FUNCTION THIS FLIGHT	EQUIPMENT/FUNCTION LUNAR MISSION	CODING
REQUIRED	REQUIRED	
REQUIRED	NOT REQUIRED	
NOT REQUIRED	REQUIRED	
NOT REQUIRED	NOT REQUIRED	

APPENDIX 503
TABLE 3. 5 - 48
LEM UNIFIED S - BAND COMMUNICATIONS AND TRACKING REQUIREMENTS
APOLLO-SATURN 503

SUBSYSTEM	EQUIPMENT IMPLEMENTATION	NUMBER OF UNITS	OPERATING FREQUENCY TRANSMIT	OPERATING FREQUENCY RECEIVE	ANTENNA SUBSYSTEM	MODULATION CHARACTERISTICS	REMARKS
VOICE COMMUNICATION (SEE NOTE 1) WITH MSFN	TRANSPONDER (PM)	TWO	S-BAND	S-BAND	OMNI-DIRECTIONAL DIRECTIONAL - VARIABLE BEAMWIDTH	FM/PM TRANSMIT - 1.25 Mc SUBCARRIER FM/PM RECEIVE 30 Kc SUBCARRIER	• TRANSPONDER FREQUENCY SHALL BE COHERENT WITH SIGNALS RECEIVED FROM THE MSFN AND IN THE RATIO OF 240:221 • TRANSPONDER ALSO PROVIDES FOR TELEMETRY TRANSMISSION, KEYED TRANSMISSION, AND TRACKING ASSISTANCE TO THE MSFN • RELAY VOICE AND TELEMETRY COMMUNICATIONS WITH EVA • BACK-UP RELAY OF VOICE COMMUNICATIONS BETWEEN MSFN AND CSM
						PM TRANSMIT AT BASEBAND	• EMERGENCY VOICE TRANSMISSION TRANSMITTED ALONE
WITH MSFN	TRANSMITTER (FM)	ONE	S-BAND		ERECTABLE (ON LUNAR SURFACE)	FM/FM TRANSMIT 1.25 Mc SUBCARRIER	• THE FM TRANSMITTER IS NOT REQUIRED TO OPERATE SIMULTANEOUSLY WITH THE PM TRANSPONDER • VOICE RECEPTION IS ACHIEVED VIA PM RECEPTION OF 30 Kc FM SUBCARRIER • TRANSMITTER ALSO PROVIDES FOR TELEMETRY AND TELEVISION TRANSMISSION TO THE MSFN • TRANSMITTER SHALL UTILIZE TRANSPONDER ANTENNA SUBSYSTEM DURING R&D FLIGHT PROGRAM.
KEYING COMMUNICATIONS TO MSFN	TRANSPONDER (PM)		S-BAND			AM/PM 512 Kc SUBCARRIER	• SEE "VOICE COMMUNICATIONS WITH MSFN" • TRANSMITTED ALONE - BACK-UP FOR VOICE TRANSMISSION
TELEMETRY TO MSFN	TRANSMITTER (FM)		S-BAND			PCM/FM/FM 1.024 Mc SUBCARRIER NRZ-C SERIAL BIT STREAM	• SEE "VOICE COMMUNICATIONS WITH MSFN" • SELECTABLE BIT RATES OF 51.2 KILOBITS/SECOND AND 1.6 KILOBITS/SECOND • SEE NOTES 2 AND 3
						FM/FM/FM 7 SUBCARRIERS ON 1.25 Mc VOICE SUBCARRIER	• SEE "VOICE COMMUNICATIONS WITH MSFN" • RELAY OF COMPOSITE EVA VOICE AND 7 CHANNELS OF EVA TELEMETRY ON VOICE SUBCARRIER
TO MSFN	TRANSPONDER (PM)		S-BAND			PCM/PM/PM 1.024 Mc SUBCARRIER NRZ-C SERIAL BIT STREAM	• SEE "VOICE COMMUNICATIONS WITH MSFN" • SELECTABLE BIT RATES OF 51.2 KILOBITS/SECOND AND 1.6 KILOBITS/SECOND • SEE NOTES 2 AND 3
						FM/FM/PM 7 SUBCARRIERS ON 1.25 Mc VOICE SUBCARRIER	• SEE "VOICE COMMUNICATIONS WITH MSFN" • RELAY OF COMPOSITE EVA VOICE AND 7 CHANNELS OF EVA TELEMETRY ON VOICE SUBCARRIER
							• SCIENTIFIC DATA
TAPE PLAYBACK							• NOT APPLICABLE
TELEVISION TO MSFN	TRANSMITTER (FM)		S-BAND			FM AT BASEBAND	• SEE "VOICE COMMUNICATIONS WITH MSFN"
UP-DATA							• NOT APPLICABLE
TRACKING AID TO MSFN	TRANSPONDER (PM)		S-BAND	S-BAND		PM RECEIVE- PRN CODE AT BASEBAND PM TRANSMIT- PRN CODE AT BASEBAND	• SEE "VOICE COMMUNICATIONS WITH MSFN" • COHERENT TURN-AROUND CARRIER • COHERENT TURN-AROUND RANGE CODE

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NOTES:

1. THE MINIMUM WORK INTELLIGIBILITY SHALL BE 90% FOR NORMAL VOICE COMMUNICATIONS AND 70% FOR BACK-UP COMMUNICATIONS AS MEASURED BY USFR PERSONNEL UNDER SIMULATED OPERATING CONDITIONS UTILIZING THE AMERICAN STANDARD METHOD FOR MEASUREMENT OF MONOSYLLABIC WORD INTELLIGIBILITY DATED MAY 25, 1960

2. THE TELEMETRY SUBSYSTEM SHALL BE DESIGNED TO PROVIDE AN ERROR RATE NOT EXCEEDING ONE BIT IN 10^6 BITS FOR PCM TELEMETRY TRANSMISSIONS TO STATIONS OF THE MSFN AS MEASURED FROM CSM ENCODER TO MSFN DECODER.

3. THIS PCM TELEMETRY SUBSYSTEM SHALL BE CAPABLE OF TRANSMITTING THE PCM BIT STREAM REQUIRED FOR REAL-TIME USE VIA COAXIAL CABLE TO THE CHECKOUT FACILITY IN THE MILA PRIOR TO LIFT-OFF AND VIA AN RF LINK AFTER ADAPTER JETTISON.

LEGEND

EQUIPMENT/FUNCTION THIS FLIGHT	EQUIPMENT/FUNCTION LUNAR MISSION	CODING
REQUIRED	REQUIRED	
REQUIRED	NOT REQUIRED	
NOT REQUIRED	REQUIRED	
NOT REQUIRED	NOT REQUIRED	

APPENDIX 503
TABLE 3.7-1
REQUIRED CSM COVERAGE

SUBSYSTEM \ PHASE	S-IC BURN	S-II BURN	S-IVB BURN	INSERTION + 3 MIN.	INSERTION + 5 MIN.	ORBIT #1	ORBIT #2	ORBIT #3	ORBIT #4 [1]	PRE-INJECTION CHECK-OUT [2]	INJECTION BURN (-1 TO +3 MIN.)	POST INJECTION TO (+15 MIN.)	TRANS-POSITION (+15 MIN. TO 2 HRS.)	COAST	MID-COURSE BURNS	CSM/LEM SEPARATION	CSM/LEM RENDEZVOUS MANEUVERS	LEM JETTISON	CM SEPARATION	CM ENTRY
CSM VHF																				
VOICE	Continuous	Continuous	Continuous	Continuous	Continuous	Partial [3]	Partial	Partial	Partial	Continuous	Continuous [4]								Partial	Partial
CSM S-BAND																				
VOICE	Continuous	Continuous	Continuous	Continuous	Continuous	Partial [3]	Partial	Partial	Partial	Continuous	Continuous [4]	Continuous [5]	Continuous	Partial	Continuous	Continuous	Continuous	Partial	Partial	Partial
TELEMETRY	Continuous	Continuous	Continuous	Continuous	Continuous	Partial [3]	Partial	Partial	Partial	Continuous	Continuous [4]	Continuous [5]	Continuous	Partial	Continuous	Continuous	Continuous	Partial	Partial	Partial
UP-DATA	Continuous	Continuous	Continuous	Continuous	Continuous	Partial [3]	Partial	Partial	Partial	Continuous		Continuous [5]	Continuous	Partial	Continuous	Continuous	Continuous	Partial	Partial	
TRACKING [6]	Continuous	Continuous	Continuous	Continuous	Continuous	Partial [3]	Partial	Partial	Partial	Continuous		Continuous [5]		Partial	Continuous	Continuous	Continuous	Partial	Partial	Partial
TELEVISION						Partial	Partial	Partial						Partial						
CSM C-BAND																				
TRACKING [6]	Continuous	Continuous	Continuous	Continuous		Partial [3]	Partial	Partial	Partial	Continuous		Partial	Partial	Partial	Partial	Partial	Partial		Partial	Partial

1. CONTINGENCY ORBIT IF INJECTION NOT ATTEMPTED.
2. THIS REQUIREMENT CAN BE SATISFIED DURING THE ORBITAL CONTACTS BEFORE INJECTION.
3. GAP BETWEEN CONTACTS SHALL BE NO GREATER THAN 1/2 ORBIT. CONTACTS SHALL BE AT LEAST 3 MINUTES LONG.
4. COVERAGE CAN BE PROVIDED BY AIRCRAFT.
5. CONTINUOUS COVERAGE FOR A MINIMUM OF 8 MINUTES.
6. S-BAND TRACKING SHALL PROVIDE DIRECT MEASUREMENT OF SPACECRAFT ANGLE, RANGE AND RANGE RATE. C-BAND TRACKING SHALL PROVIDE DIRECT MEASUREMENT OF SPACECRAFT ANGLE AND RANGE.

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PARTIAL
CONTINUOUS
NOT REQUIRED

TABLE 3.7-1
APOLLO-SATURN 503

APPENDIX 503
TABLE 3.7-2
REQUIRED LEM COVERAGE
APOLLO-SATURN 503

SUBSYSTEM \ PHASE	ADAPTER JETTISON	TRANSPOSITION	COAST PERIODS	-2 MINUTES TO CSM SPS BURNS	CSM SPS-BURNS	LEM/CSM SEPARATION	DPS AND APS BURNS	LEM/CSM RENDEZVOUS MANEUVERS	LEM JETTISON
VHF									
VOICE			PARTIAL COVERAGE			PARTIAL COVERAGE	PARTIAL COVERAGE	PARTIAL COVERAGE	
TELEMETRY			PARTIAL COVERAGE			PARTIAL COVERAGE	PARTIAL COVERAGE	PARTIAL COVERAGE	CONTINUOUS COVERAGE
UHF									
UP-DATA			PARTIAL COVERAGE			CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	PARTIAL COVERAGE	
C-BAND									
TRACKING [1]		PARTIAL COVERAGE	PARTIAL COVERAGE			PARTIAL COVERAGE	PARTIAL COVERAGE	PARTIAL COVERAGE	
S-BAND									
VOICE			PARTIAL COVERAGE			CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	
TELEMETRY		CONTINUOUS COVERAGE	PARTIAL COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE
TRACKING [1]		CONTINUOUS COVERAGE	PARTIAL COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE	CONTINUOUS COVERAGE
TELEVISION			PARTIAL COVERAGE						

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1. S-BAND TRACKING SHALL PROVIDE DIRECT MEASUREMENT OF LEM ANGLE, RANGE AND RANGE RATE. C-BAND TRACKING SHALL PROVIDE DIRECT MEASUREMENT OF LEM ANGLE AND RANGE.

PARTIAL COVERAGE
CONTINUOUS COVERAGE
NOT REQUIRED

TABLE 3.7-2
APOLLO-SATURN 503

APPENDIX 503
TABLE 3.7-3
REQUIRED SATURN V LAUNCH VEHICLE COVERAGE
APOLLO-SATURN 503

SUBSYSTEM \ PHASE	S-IC BURN	S-II BURN	S-IVB BURN	INSERTION +3 MIN.	INSERTION +5 MIN.	ORBIT #1	ORBIT #2	ORBIT #3	ORBIT #4 (3)	PRE-INJECTION CHECK-OUT (4)	INJECTION BURN (-1 to +3 MIN.)	POST INJECTION (to +15 MIN.)	TRANSPOSITION (+15 MIN to 2 HRS.)
TELEMETRY													
S-IC VHF	Continuous 1												
S-II VHF	Continuous	Continuous 1											
S-IVB VHF	Continuous	Continuous	Continuous	Continuous	Continuous	Partial 2	Partial	Partial	Partial	Continuous	Continuous 5		
IU VHF	Continuous	Continuous	Continuous	Continuous	Continuous	Partial 2	Partial	Partial	Partial	Continuous	Continuous 5		
IU S-BAND	Continuous	Continuous	Continuous	Continuous	Continuous	Partial 2	Partial	Partial	Partial	Continuous	Continuous 5	Continuous 6	Continuous
IU CCS	Continuous	Continuous	Continuous	Continuous	Continuous	Partial 2	Partial	Partial	Partial	Continuous	Continuous 5	Continuous 6	Continuous
UP-DATA													
IU CCS	Partial	Partial	Partial	Continuous	Continuous	Partial 2	Partial	Partial	Partial	Continuous		Partial	Continuous
TELEVISION													
S-IC S-BAND	Continuous 10												
COMMAND DESTRUCT													
S-IC	Continuous 7												
S-II	Continuous	Continuous 7											
S-IVB	Continuous	Continuous	Partial 7										
TRACKING													
IU CCS	Partial 8	Partial 8	Partial 8	Continuous		Partial 2	Partial	Partial	Partial	Continuous 9		Partial	Continuous
IU C-BAND	Continuous 8	Continuous 8	Continuous 8	Continuous		Partial 2	Partial	Partial	Partial	Continuous 9		Partial	
AZUSA	Partial 8	Partial 8	Partial										
ODOP	Partial 8												

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1 COVERAGE SHALL CONTINUE FOR AT LEAST ONE MINUTE AFTER THE END OF BURN

2 GAP BETWEEN CONTACTS SHALL BE NO GREATER THAN 1/2 ORBIT. CONTACTS SHALL BE AT LEAST 3 MINUTES LONG.

3 CONTINGENCY ORBIT IF INJECTION NOT ATTEMPTED.

4 THIS REQUIREMENT CAN BE SATISFIED DURING THE ORBITAL CONTACTS BEFORE INJECTION.

5 COVERAGE CAN BE PROVIDED BY AIRCRAFT.

6 CONTINUOUS COVERAGE FOR A MINIMUM OF 8 MINUTES.

7 CONTINUOUS COVERAGE UNTIL THE PREDICTED IMPACT POINT OF THE VEHICLE IS OUTSIDE AREAS SPECIFIED BY RANGE SAFETY.

8 TWO LAUNCH VEHICLE TRANSPONDERS SHALL BE TRACKED CONTINUOUSLY TO SATISFY RANGE REQUIREMENTS.

9 THIS REQUIREMENT CAN BE SATISFIED BY EITHER IU CCS OR IU C-BAND.

10 TELEVISION TRANSMISSION SHALL BE RECEIVED BY THE CENTRAL INSTRUMENTATION FACILITY IN THE LAUNCH AREA.

PARTIAL
CONTINUOUS
NOT REQUIRED

Apollo Saturn Missions 504 and 505

1.0 Scope This appendix to the Apollo Program Specification identifies the performance, design and test requirements which apply to the Program elements to be utilized for Apollo Saturn Mission 504 (AS-504) and for Apollo Saturn Mission 505 (AS-505). These requirements are presented in this appendix as deviations to the requirements specified in the body of the specification. Unless otherwise noted, the paragraphs in this appendix replace in their entirety the identically numbered paragraphs in the body of the specification.

1.1 Applicability No change.[1]

1.2 Change Approval No change.

2.0 Applicable Documents No change.

3.0 Requirements

3.1 Performance No change.

3.2 Program Standards No change.

3.3 Saturn IB Launch Vehicle N/A.

(1) The phrase "no change" is used after a section heading throughout this appendix to mean that the requirement in the body of the specification applies to this mission without change.

Apollo Saturn Missions 504 and 505

3.4 Saturn V Launch Vehicle

3.4.1 General No change except that the launch vehicle control weights shall be as specified for AS-504 and for AS-505 in Table 10.1-2, Appendix 10.1.

3.4.1.1 Payload No change except that the payload capability shall be as specified for AS-504 and AS-505 in Table 10.1-2, Appendix 10.1.

3.4.1.2 Standby Time No change.

3.4.1.3 Prelaunch Checkout No change.

3.4.1.4 In-Flight Performance Evaluation No change.

3.4.1.5 Emergency Detection Subsystem (EDS) No change.

3.4.1.6 Instrumentation Add: "The instrumentation subsystem shall be designed so that, where practical, the components of the subsystem not required for operational flights are removable."

3.4.1.7 Command Destruct No change.

3.4.1.8 Electrical Power No change.

3.4.1.9 Attitude Control No change.

3.4.2 Structure No change.

3.4.3 Propulsion No change.

3.4.4 Guidance, Navigation and Control No change.

3.4.5 Saturn V Launch Vehicle Communications and Tracking

3.4.5.1 General No change.

3.4.5.2 Functional Capability No change.

3.4.5.3 Coverage Capability No change.

Apollo Saturn Missions 504 and 505

3.4.5.4 Performance No change except the Saturn V Communication and Tracking System shall meet the requirements specified in Table 3.4-1 (504/505) of this appendix.

3.5 Spacecraft

3.5.1 General No change except the spacecraft control weights shall be as specified for AS-504 and AS-505 in Table 10.1-4, Appendix 10.1. The LEM shall be capable of accommodating the temperature of lunar day as given in 5.7 of M-DE 8020.008B.

3.5.2 Command and Service Modules No change.

3.5.3 Lunar Excursion Module No change.

3.5.4 Launch Escape System No change.

3.5.5 Adapter No change.

3.5.6 Extravehicular Mobility Unit No change.

3.5.7 Scientific Payload No change.

3.5.8 Flight Crew Training Equipment No change.

3.6 Launch Area The requirements of this section, which are identified with LC 39 and the Direct Launch Support Facilities, are applicable without change. All other requirements of this section are not applicable.

Apollo Saturn Missions 504 and 505

3.7 Manned Space Flight Network No change.

3.8 Mission Control Center No change.

4.0 Quality Assurance No change.

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APPENDIX 504/505

TABLE 3. 4 - 1

SATURN V LAUNCH VEHICLE COMMUNICATIONS AND TRACKING REQUIREMENTS

APOLLO - SATURN 504/505

STAGE / SUBSYSTEM	EQUIPMENT IMPLEMENTATION	NUMBER OF UNITS	OPERATING FREQUENCY TRANSMIT	OPERATING FREQUENCY RECEIVE	ANTENNA SUBSYSTEM	MODULATION CHARACTERISTICS	REMARKS
S - IC TELEMETRY	PCM/FM TELEMETER	ONE	225-260 Mc		OMNI-DIRECTIONAL	PCM/FM	• SEE NOTES 1, 2 AND 3 • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND
	FM/FM TELEMETER	ONE	225-260 Mc		SEE NOTE 5	FM/FM	• SEE NOTES 1 AND 4 • PAM/FM/FM MODULATION UTILIZED DURING R & D FLIGHT PROGRAM
	PAM/FM/FM TELEMETER 6	TWO	225-260 Mc		SEE NOTE 5	PAM/FM/FM	• SEE NOTES 1 AND 4
	SS/FM TELEMETER 6	TWO	225-260 Mc		SEE NOTE 5	SS/FM	• SEE NOTE 4
COMMAND DESTRUCT	RECEIVER AND DECODER	TWO		400-450 Mc	OMNI-DIRECTIONAL		• THIS SYSTEM SHALL BE COMPATIBLE WITH RANGE SAFETY COMMAND TRANSMITTERS INSTALLED AT STATIONS OF THE ETR
TRACKING	ODOP TRANSPONDER 8	ONE	UHF	UHF	FIXED DIRECTIONAL		
TELEVISION	TELEVISION TRANSMITTER	ONE	1700-1730 Mc				
S - II TELEMETRY	PCM/FM TELEMETER	ONE	225-260 Mc		OMNI-DIRECTIONAL	PCM/FM	• SEE NOTES 1, 2 AND 3 • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND
	FM/FM TELEMETER	TWO	225-260 Mc		SEE NOTE 5	FM/FM	• SEE NOTES 1 AND 4 • PAM/FM/FM MODULATION UTILIZED DURING R & D FLIGHT PROGRAM
	PAM/FM/FM TELEMETER 6	ONE	225-260 Mc		SEE NOTE 5	PAM/FM/FM	• SEE NOTES 1 AND 4
	SS/FM TELEMETER 6	ONE	225-260 Mc		SEE NOTE 5	SS/FM	• SEE NOTE 4
COMMAND DESTRUCT	RECEIVER AND DECODER	TWO		400-450 Mc	OMNI-DIRECTIONAL		• THIS SYSTEM SHALL BE COMPATIBLE WITH RANGE SAFETY COMMAND TRANSMITTERS INSTALLED AT STATIONS OF THE ETR
S - IVB TELEMETRY	PCM/FM TELEMETER	ONE	225-260 Mc		OMNI-DIRECTIONAL	PCM/FM	• SEE NOTES 1, 2 AND 3 • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND
	FM/FM TELEMETER 7	ONE	225-260 Mc		SEE NOTE 5	FM/FM	• SEE NOTES 1 AND 4
	PAM/FM/FM TELEMETER	TWO	225-260 Mc		SEE NOTE 5	PAM/FM/FM	• SEE NOTES 1 AND 4
	SS/FM TELEMETER	ONE	225-260 Mc		SEE NOTE 5	SS/FM	• SEE NOTE 4
COMMAND DESTRUCT	RECEIVER AND DECODER	TWO		400-450 Mc	OMNI-DIRECTIONAL		• THIS SYSTEM SHALL BE COMPATIBLE WITH RANGE SAFETY COMMAND TRANSMITTERS INSTALLED AT STATIONS OF THE ETR
INSTRUMENT UNIT TELEMETRY	PCM/FM TELEMETER	ONE	225-260 Mc		OMNI-DIRECTIONAL	PCM/FM	• SEE NOTES 1, 2 AND 3 • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND • THE TELEMETRY SHALL CONTAIN ALL S-IVB/IU MISSION CONTROL DATA
	PCM/FM TELEMETER 8	ONE	S-BAND		FIXED DIRECTIONAL VARIABLE BEAMWIDTH	PCM/FM	• SEE NOTES 1 AND 2 • PCM BIT RATE SHALL BE 72 KILOBITS/SECOND • TRANSMITS THE SAME BIT STREAM AS THE IU VHF PCM/FM TELEMETER
	FM/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF IU VHF PCM/FM TELEMETER	FM/FM	• SEE NOTES 1 AND 4
	PAM/FM/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF IU VHF PCM/FM TELEMETER	PAM/FM/FM	• SEE NOTES 1 AND 4
	SS/FM TELEMETER	ONE	225-260 Mc		MULTIPLEXED WITH OUTPUT OF IU VHF PCM/FM TELEMETER	SS/FM	• SEE NOTES 4
	COMMAND AND COMMUNICATION SYSTEM (CCS)	ONE	S-BAND		MULTIPLEXED WITH OUTPUT OF IU S-BAND PCM/FM TELEMETER	PCM/PM/PM	• THIS SYSTEM SHALL PROVIDE TELEMETRY TRANSMISSION, UP-DATA RECEPTION AND TRACKING ASSISTANCE TO THE MSFN • UTILIZES SAME OPERATING FREQUENCIES AS THE LEM USB SYSTEM • SEE NOTE 2 • THE CCS TRANSMITS THE SAME BIT STREAM AS THE S-IVB VHF PCM/FM TELEMETER AT A BIT RATE OF 72 KILOBITS/SECOND
UP - DATA	CCS			S-BAND		PSK/FM/PM SUBCODED 5-BIT WORDS AT 1000 BITS/SECOND	• NO MORE THAN ONE CORRECT MESSAGE SHALL BE REJECTED PER 1000 CORRECT MESSAGES AND NO MORE THAN ONE PER 10^9 INCORRECT MESSAGES SHALL BE ACCEPTED
TRACKING AID	CCS		S-BAND	S-BAND		PM	• TRANSMITTED FREQUENCY SHALL BE IN THE RATIO OF 240:221 TO THE RECEIVED FREQUENCY • COHERENT TURN-AROUND CARRIER • COHERENT TURN-AROUND RANGE CODE
	C-BAND RADAR TRANSPONDER	ONE	C-BAND	C-BAND	OMNI-DIRECTIONAL	PULSE	• UTILIZES CODING DIFFERENT FROM C-BAND RADAR TRANSPONDERS ON SPACECRAFT
	AZUSA TRANSPONDER	ONE	C-BAND	C-BAND	OMNI-DIRECTIONAL	FM	

3/1/66

NOTES:

1. THIS TELEMETRY SUBSYSTEM SHALL BE COMPATIBLE WITH THE INTER RANGE INSTRUMENTATION GROUP STANDARDS (IRIG DOCUMENT NO. 106-60 "TELEMETRY STANDARDS REVISED 1962").
2. ALL PCM TELEMETRY SUBSYSTEMS SHALL BE DESIGNED TO PROVIDE AN ERROR RATE NOT EXCEEDING ONE IN 10^6 BITS FOR TRANSMISSIONS TO THE MSFN AS MEASURED FROM LAUNCH VEHICLE ENCODER TO EARTH-BASED DECODER.
3. THIS PCM/FM TELEMETRY SUBSYSTEM SHALL TRANSMIT THE PCM BIT STREAM REQUIRED FOR REAL-TIME USE VIA COAXIAL CABLE TO THE CHECKOUT FACILITY IN THE MILA PRIOR TO LIFT-OFF AND VIA AN RF LINK PRIOR TO AND AFTER LIFT-OFF.
4. THIS TELEMETRY SUBSYSTEM SHALL TRANSMIT DATA REQUIRED ONLY FOR POST-MISSION ANALYSIS VIA AN RF LINK.
5. UP TO 4 VHF STAGE TELEMETERS SHALL BE MULTIPLEXED ON A COMMON ANTENNA SUBSYSTEM. WHEN MORE THAN 4 VHF STAGE TELEMETERS ARE CARRIED, A SECOND OMNI-DIRECTIONAL ANTENNA SUBSYSTEM SHALL BE PROVIDED.
6. THESE TELEMETERS SHALL BE REMOVABLE ON AS-504 AND AS-505.
7. NOT PRESENTLY SCHEDULED; HOWEVER, PROVISIONS TO CARRY THIS TELEMETER SHALL BE INCORPORATED ON AS-504 AND AS-505.
8. POSSIBILITY OF REQUIREMENTS BEING FULFILLED BY THE CCS.

LEGEND

EQUIPMENT/FUNCTION: THIS FLIGHT	EQUIPMENT/FUNCTION: LUNAR MISSION	CODING
REQUIRED	REQUIRED	
REQUIRED	NOT REQUIRED	
NOT REQUIRED	REQUIRED	
NOT REQUIRED	NOT REQUIRED	